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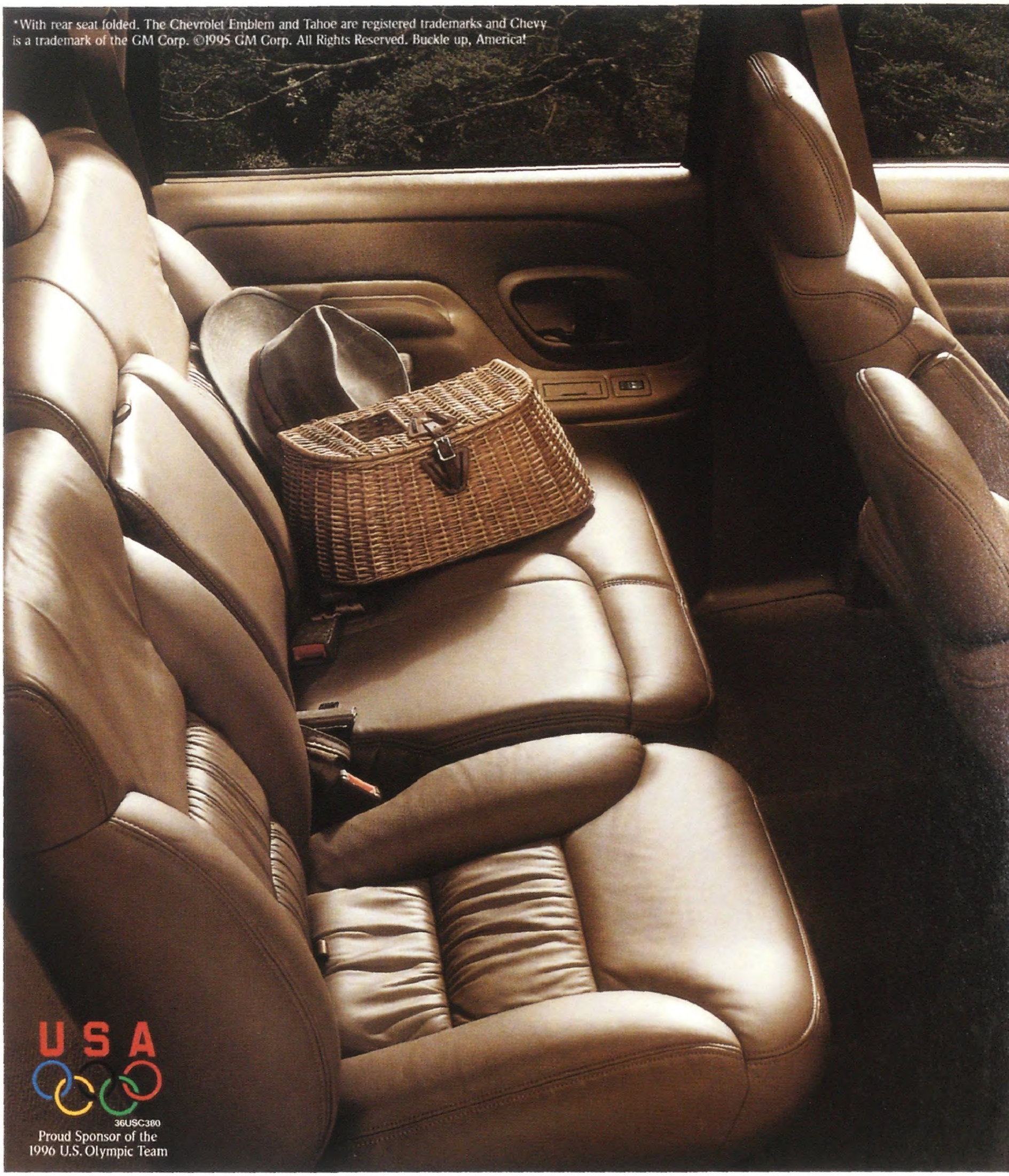

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August/September 1995
Volume 10, Number 3

AIR&SPACE
Smithsonian

The End of World War II: A 50th Anniversary Commemoration

64 A Pacific War Album
Photographs from the collection of Loomis Dean, with text adapted from Loomis Dean, James Edmundson, and Allen Rankin

Long buried in the Pentagon's archives, a trove of photos offers an intimate look at the world revolving around the B-29 in the last months of the Pacific war.

74 The Last Raid
by Daniel Ford
Illustrations by Greg Harlin/ Wood Ronsaville Harlin, Inc.
Even following the atomic bombings of Hiroshima and Nagasaki, the war dragged on for six uncertain days.

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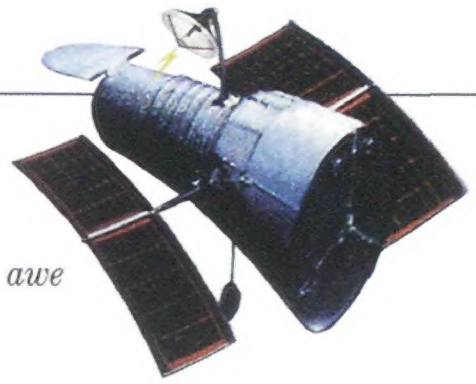

Cover:
"It was fantastic to see that many big airplanes flying so close together," says Loomis Dean of the B-29s he photographed in the last months of the war.

Departments

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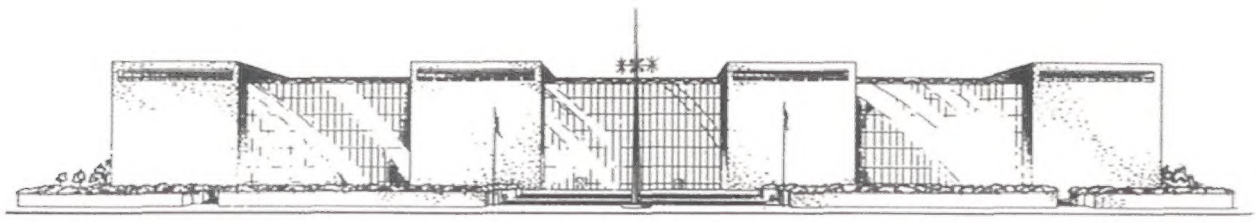

Online

The tabloids are filled with people claiming to be from another planet, but we don't believe them. These days, if they told us they'd never heard of the World Wide Web, we might.

The Web is the newest part of the Internet communication network for computers, and with its powerful combination of text, graphics, and hyperlinks to other Web pages, it is the medium publishers have been dreaming about. Now *Air & Space/Smithsonian* is accessible to members and non-members alike by typing this locator code into any standard web browser:

http://airspacemag.com

We've launched our services on the Web in response to a Smithsonian-wide initiative by Secretary I. Michael Heyman to make the resources of the Institution accessible to the public on the Internet; the Smithsonian web site (http://www.si.edu) has been operating since May. The National Air and Space Museum's Center for Earth and Planetary Studies (http://www.nasm.edu) has served up a Web page for more than a year, offering downloads of its image library, and now CEPS has created dozens of pages that provide a virtual catalog of the entire Museum.

The *Air & Space/Smithsonian* web site will be in a perpetual state of construction and revision as we continue to add information, entertainment, and services that match the needs of our readers. One service already available is a complete index of back issues that is searchable by keyword. And in the future we'll be adding a second index that will be written specifically for keyword searches, which will make the search feature even more useful.

The first page that greets you is our home page, with links to six areas of interest. A "What's New" section points out the most recent additions to our Web pages. "In the News" takes you to information that adds depth to stories currently making headlines. When Air Force captain Scott O'Grady's rescue from Bosnia became the escape-and-evasion story of the decade, we searched our archives and located Fred Reed's story "Survival 101," which appeared in our Oct./Nov. 1992 issue and described the training military fliers receive in the services' survival schools. You'll notice that both Reed's story and Larry Lowe's "The Last Piston Show," together with Jim Sugar's photos (from Apr./May 1992), are presented in a unique way to eliminate long download times. We don't like to wait five minutes for a page, and we bet you don't either.

You'll also be able to register your opinion on a wide range of aerospace topics in our polling place, the AIR&SPACE Webline in the "Feedback" section. If you leave us your e-mail address, we'll even send you the poll results. We'll update the poll questions periodically to reflect events and current trends, and the subjects covered will be wide-ranging. One question in the current poll: Who's your favorite Starship commander?

Our "Aerospace Expo" section contains fun and excitement, with descriptions of everything from travel and tours to rides and adventures like a flight in a DC-3 or a day of aerial combat with Air Combat USA. That company, based in Fullerton, California, teaches dogfighting, offering clients a chance to fly against an opponent in a real military trainer. There's even a section where you can order *Air & Space/Smithsonian* magazine online, with provisions for gift orders as well as renewals.

One thing we don't plan to do is publish the magazine in electronic form—not at this point, anyway. Our Web pages will complement the magazine, not substitute for it; our experience has been that reading long passages on a screen is not much fun. This magazine, on the other hand, can be folded, put in your briefcase, and read on your next flight. Although electronic services have come a long way, nothing we've seen to date promises to replace the medium that you're reading right now.

—George C. Larson

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LETTERS

About the Beast

My husband, now retired from the Air Force, spent 22 years with B-52s ("Death of the Beast," June/July 1995). We lived in base housing, and whenever the B-52s would take off and land, my windows, doors, and dishes would rattle. At first I was scared of the bombers, but I learned what the crews' duties were, and I watched my husband and other military personnel wear their uniforms with pride and dignity. I also learned and believed in the motto of the Strategic Air Command: "Peace is our profession."

These B-52s were a part of my family. To see them destroyed is like losing loved ones.

—Vickie S. Focht
Elkridge, Maryland

"Death of the Beast" (June/July 1995) illustrated the irony of the cold war. First the U.S.S.R. and the U.S. spend trillions of rubles and dollars on these weapons of war; now they're spending bundles more to destroy them. The winners in this comedy of errors are the politicians, the arms manufacturers, and the scrap collectors. When will we ever learn?

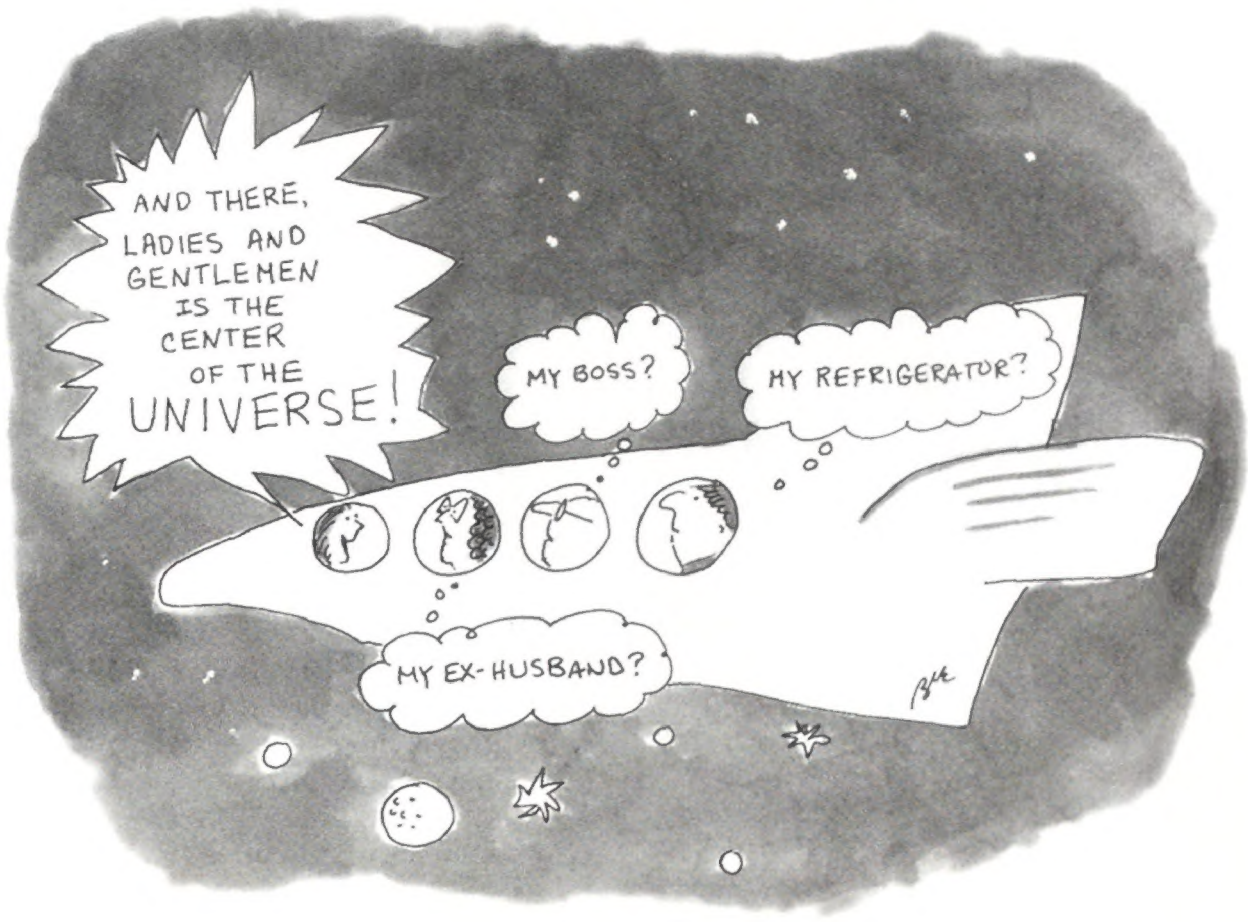
—Commander Peter A. Williams
U.S. Navy (ret.)
Gardnerville, Nevada

The last photo in "Death of the Beast" shows a B-52 with what appears to be the insignia of the Army Air Forces. But B-52s didn't enter service until well after the Army Air Forces had become the U.S. Air Force. How do you explain this?

—Joel Caesar
via e-mail

Editors' reply: Bob Chilgreen of the Aircraft Maintenance and Regeneration Center suspects that on the aircraft pictured, the red horizontal stripes used in the Air Force insignia faded away, leaving what looks like the Army Air Forces insignia.

At first I did not want to open your latest issue. The cover picture of the broken



BUFFs ("Big Ugly Fat Fellows") was too disheartening for this old B-52 crew chief. I finally succumbed to my curiosity and turned to "Death of the Beast." While I enjoyed the article, I was disappointed to see a pilot featured and a reference to "his old bomber." These aircraft did not belong to the aircrews. The Strategic Air Command did not assign aircrews to individual aircraft; the crews flew whatever plane was in the flying schedule. The only name on the side of these aircraft was that of the crew chief. He is the one who spent more time and energy on the bombers than anyone else and could rightfully claim that these magnificent workhorses were "his." But you probably wouldn't have found a crew chief who could have stood there and watched the destruction of something he had poured his heart and soul into.

"Many Sixes" (as no. 666 was known in Guam during the Bullet Shot operations in 1972) deserved a more fitting and dignified end to a glorious career.

—George E. Coleman
Command Master Sgt., U.S. Air Force
RAF Mildenhall, United Kingdom

One Step at a Time

Reader Ed Dempsey is talking through his hat when he trashes the idea of a space station in favor of a moon base (Letters, June/July 1995). Simple physics still speaks very much in favor of using a space station as a construction pad and stepping stone. Writer Robert Heinlein once observed that getting from Earth to the moon with no intermediate steps would require a spacecraft that combined the qualities of a subway train, an express elevator, and a ferry boat. The grotesque size of the Saturn V launcher used in the Apollo program bears him out. Though the program was a magnificent deed, by grabbing for the brass ring without going through intermediate steps, it had no permanent results. Instead, it left the public asking NASA: "What's your next stunt?"

—Charles J. Hitchcock
Brighton, Massachusetts

More Clipper History

As a Pan Am retiree, I rubbed elbows with many aviation pioneers at Pan American Airways, and I would like to correct a couple of statements in John Marshall's introduction to the fine article "The Long Way Home" (Above & Beyond, June/July 1995). There is one member of the crew of that around-the-world trip who is still alive. Eugene Leach was taken on in Noumea for the leg to Auckland. Initially, Captain Ford assigned him to alternate radio watches with John Poindexter; when word came that Pearl Harbor had been attacked, Ford had him work as a flight radio officer for the rest of the trip. Today, Leach lives in California and enjoys retirement, grandchildren, and amateur radio operating.

Second, though the public came to refer to the aircraft as the *Pacific Clipper* because of that around-the-world flight, it was actually named the *California Clipper*. Its designation was NC 18602, not NC 18809, as depicted in the illustration.

—Robert L. Williams
San Carlos, California

Editors' note: When we contacted Eugene Leach, he told us it was he, not Poindexter, who received the message that Pearl Harbor had been attacked. Leach was 21 at the time, and he remembers worrying about his family, who lived in Oakland, California.

A Big, Fat Omission

"Go With the Flow" (June/July 1995) left out an important part of the history of boundary layer research: the role of the airship. According to a 1959 *New York Times* article, researchers at the Lakehurst, New Jersey Naval Air Station, attempting to improve the flight characteristics of blimps designed for anti-submarine warfare and early warning systems, placed holes in a blimp's projecting fins and along the intersection of the fins and the blimp's body. The article reports: "The Lakehurst researchers figure that the holes, along with other streamlining modifications, may increase the ship's range threefold or its speed by as much as 40 percent."

The fact is, a lot of good aerospace concepts are never developed for lack of a suitable testing platform. The airship provided a flying testbed that gave us everything from the airborne gyroscope to reversing propellers.

—R.G. Van Treuren
Naval Airship Association
Edgewater, Florida

Repairing a Bad Reputation

I researched the relationship between NASA's public affairs office, the astronauts, and the media for my master's thesis in 1977, and contrary to what was stated in "Houston, We Have a Movie" (June/July 1995), I found no evidence that NASA hid information about the Apollo 13 mission. Instead, all parties involved praised NASA for playing the event so openly before the world, and this was regarded as the highpoint in the history of NASA's public affairs office. When it came to openness in handling the media, NASA had the best track record of all the government agencies at the time—a credit to Julian Scheer, who headed the public affairs office then.

—Mike Whye
Council Bluffs, Iowa

I don't think the question is whether *Apollo 13* will repair the mission's reputation but whether the movie will repair Hollywood's reputation for the earlier *Capricorn I*, a movie about the faking of a manned trip to Mars. That movie played into the rumor that the moon landings were simply a hoax, with the lunar broadcasts actually made from a Hollywood set.

I hope *Apollo 13* will inspire a new outlook toward our space program. Certainly the timing is good: Our space shuttle docked with the Russian Mir space station as the movie debuted. Perhaps the two events will again inspire us, and we will return to the moon or go on to explore Mars. I hope the summer of 1995 will mark a turning point in our long stagnation.

—Kevin Cousineau
Tehachapi, California

Who Shot the Red Baron?

In "Hangar History" (Soundings, June/July 1995), Phil Scott refers to Roy Brown as "the Royal Air Force pilot who shot down Manfred von Richthofen in World War I." The credit for that shootdown has long been the subject of controversy. Brown's pass at Richthofen was from above and behind, but the bullet that killed the Red Baron traveled upward through his chest, and he wasn't flying inverted. In addition, after Brown's pass, Richthofen flew on for about a mile and a half before breaking off his pursuit, which would have been impossible with the injuries he suffered on that flight.

—Chip Chilton
Madison, Tennessee

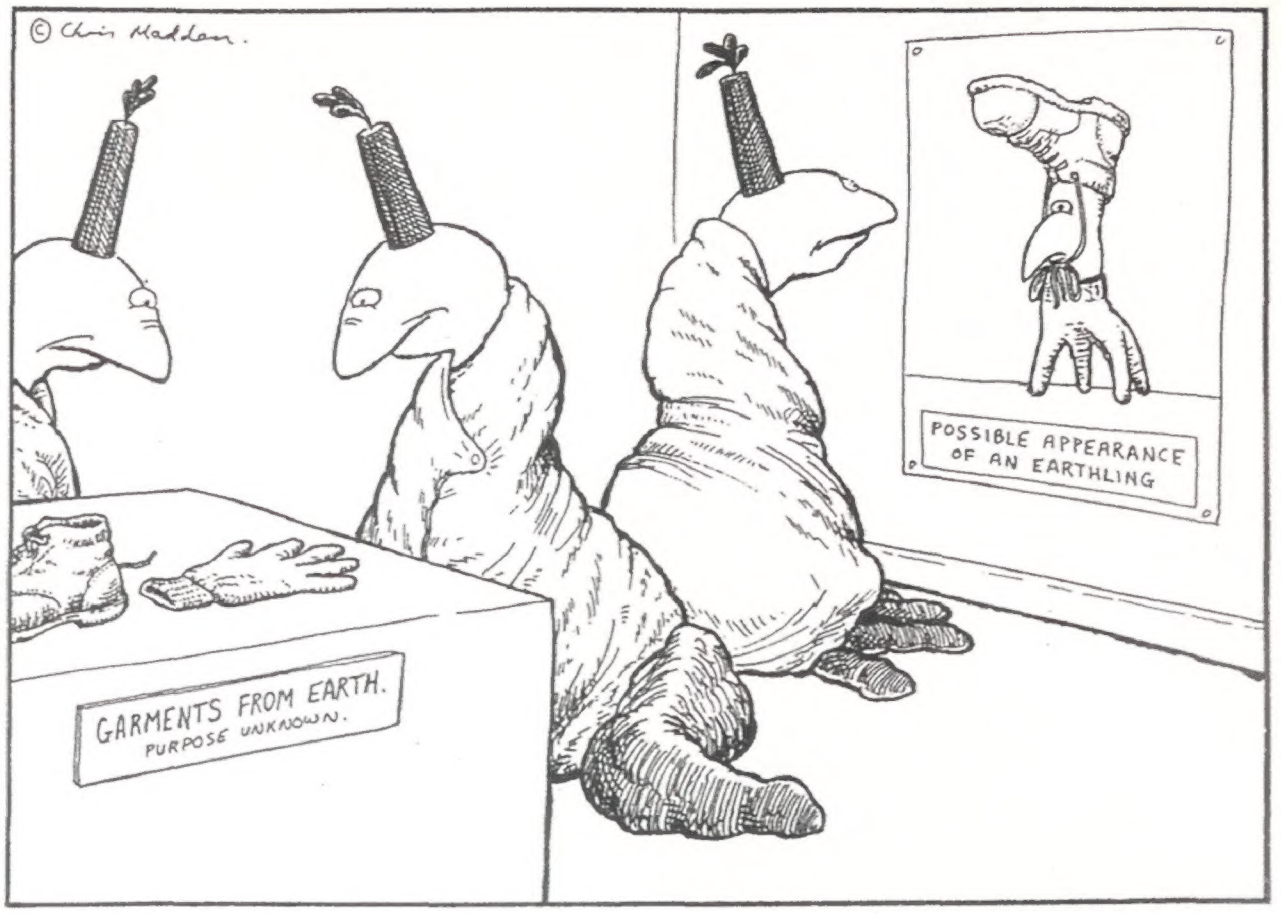
Editors' reply: You're right about the controversy. According to Peter Kilduff's recent biography Richthofen: Beyond the Legend of the Red Baron *(John Wiley & Sons, 1994), "the trajectory of the fatal bullet...was such that proponents of either argument could use it to strengthen their arguments. As the triplane twisted and turned in those final moments, it* could have been on a plane *with ground gunners; and, during Brown's pursuit, he* could have fired from off-centre *and caused such a fatal wound" (author's emphases).*

Never Say Never

In "Cleared for Landing" (From the Field, Apr./May 1995), Bill Burcham says he hopes his propulsion-controlled airplane system "never has to be used." I foresee a day when a PCA system will function not as a backup in an emergency but as a permanent replacement of aerodynamic flight controls such as ailerons, elevators, rudders, cables, pulleys, valves, actuators, tubes, and hoses. It may turn out that a PCA system will have more of an impact on cost and performance than on safety.

"I'm sorry, sir. I don't think we're equipped to handle emotional baggage."

—Tim Sanders
Wichita, Kansas



Still Waiting for Number Nine

I too was a Tom Corbett fan ("The Original Space Cadet," Apr./May 1995). I faithfully watched the TV show, collected the comics, lugged a Tom Corbett lunchbox to school, and read—and reread—the books. In fact, after finishing the eighth and final book in the series, I even wrote to Grosset & Dunlap requesting more (and suggesting several plot lines). Though an editor wrote back assuring me that the writer was currently at work on a manuscript, no new title ever appeared.

I've always wondered about the identity—or identities—of the series' author. Does "Carey Rockwell" bear any resemblance to Tom Swift's "Victor Appleton" or the Hardy Boys' "Franklin W. Dixon"? Perhaps some reader can help.

—T.E.D. Klein
New York, New York

Close Enough for Government Work

In "The Secret Weapon" (Feb./Mar. 1995), Don Sherman, referring to the lack of precision in the Army Air Forces' strategic precision bombing campaign of World War II, states: "Fault lies with the precision strategic bombing doctrine" and that "the doctrine was fundamentally flawed." I disagree. It was only the Army Air Forces' use of the term "precision" that was flawed. The military knew that the technology was not capable of true precision, and after all, precision guided munitions were not developed for another two decades. But the Norden bombsight was state-of-the-art technology, and strategic bombing was the best use of it. It may not have been efficient, but it was effective enough. Without it the Axis powers would have been left unmolested to produce war materiel.

—Gerry Gladhill
Westminster, California

Corrections

June/July 1995 "The Eagles Have Landed," pp. 74-75: The left-right orientation of the photo was inadvertently reversed. p. 77: The Sea Fury, an example of which Charlie Hillard is restoring, was produced by Hawker, not de Havilland.

Apr./May 1995 "Falling Blossoms" (In the Museum): The Ohka's designation was MXY7, not MX7Y.

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The Skunk Works' Newest Star

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The lights dim, music from the movie *The Rocketeer* plays portentously, and a giant curtain drawn across the hangar slowly opens to reveal a...what? A winged platypus? A ruler bisected by a bathtub? The UFO supposedly hidden in Hangar 18 all these years?

"I think it's time that you get a look at the newest star in the world of airborne reconnaissance," says Jack S. Gordon, president of the Lockheed Martin Skunk Works, at the unveiling in Palmdale, California, last June. "Ladies and gentlemen, I present DarkStar."

Even by the standard of the Skunk Works, whose previous reconnaissance aircraft include the legendary U-2 and SR-71 Blackbird, DarkStar is an exceedingly odd duck. First of all, it's a flying wing. Second, it doesn't have a cockpit. It's an unmanned aerial vehicle, or UAV, and if the hype is to be believed, it represents "the cornerstone of a revolution in military affairs," according to Air Force major general Kenneth R. Israel, director of the Defense Airborne Reconnaissance Office.

Although UAVs are nothing new, U.S. military planners have tended to dismiss them as expensive, fragile, complicated, or unreliable—often all of the above. But the anti-UAV prejudice no longer seems justified in an age when virtual reality has become reality. "We now have the technology to collect data without putting lives at risk," says Larry Lynn, acting director of the Department of Defense's Advanced Research Projects Agency.

ARPA and DARO are funding the development of two high-altitude, long-endurance UAVs, each priced at $10 million. Although both are being designed to provide near-real-time, continuous, all-weather surveillance, they embody contrasting philosophies. One, known as Tier II Plus, maximizes payload and endurance. The other, Tier III Minus, mercifully nicknamed DarkStar, is designed for low observability so it can survive in what's known euphemistically as a high-threat environment. It's supposed to loiter over hostile battlefields for eight hours at a stretch, peering down at the enemy while remaining undetected itself—ergo the bizarre, radar-unfriendly shape, only 15 feet long yet 69 feet wide.

"Everything we did was driven by two fundamental factors: aero-efficiency and a low radar cross-section," explains Richard Alldredge, director of UAV programs for Boeing, Lockheed's partner on DarkStar. "But you can see how our stealth technology has matured from faceted surfaces to something that's a lot more flowing."

The compact fuselage has the organic, thrusting look of a stingray with a cyclops-like eye in the middle. (This is the intake for the Williams-Rolls FJ44 turbofan engine, the same engine that powers the Cessna CitationJet.) Weirder still, the pod extends forward of, but not behind, the slender, unswept wings. From the top, DarkStar will look like it's flying backward.

DarkStar hasn't gotten off the ground yet; the first flight is scheduled for this fall. But when it does fly, it will do so via pre-loaded mission programs, without the aid of the ground-based human "pilots" armed with joysticks and video screens that most other UAVs require. The onboard computers also will perform another critical task—keeping the strange craft in the air. "It is inherently unstable," Alldredge confirms as he gazes at DarkStar. "Take your hands off this one and it would end up [flying as well as] a venetian blind."

—Preston Lerner

TIM WRIGHT

Up in Smoke

"Go Darryl go!" hollered Mat Jackson as his boss, Darryl Greenamyer, throttled across the snow-covered tundra in a B-29 Superfortress that hadn't budged in 48 years.

The Boeing bomber had been on a top-secret reconnaissance mission over the North Pole in 1947 when, lost and low on fuel, it belly-flopped onto a lakebed 950 miles above the Arctic Circle in northern Greenland. The 11 crewmen were rescued, but *Kee Bird* stayed behind. Over the years, the number of airworthy B-29s, originally near 4,000, fell to one—and the long-abandoned *Kee Bird* attracted Greenamyer's attention. "That bird's like a rare piece of art," said Donald Sachs, a Boeing historian. "I wouldn't even want to speculate on what it's worth, but it'll be in the millions."

Greenamyer, a former Lockheed Skunk Works test pilot and holder of a low-altitude jet speed record set in 1977 in an F-104, spent some $500,000 trying to resurrect the bomber. Last summer he and a crew of five fought freezing rain and high winds in primitive conditions to install four rebuilt Wright Cyclone 18-cylinder engines and new propellers, flight controls, and rudder. Two weeks stretched to six and summer turned to winter. When blizzards shredded tents and lead mechanic Rick Kriege collapsed and died in a Canadian hospital from a swollen spleen and blood clots in his lungs, the crew fled, just days from finishing.

They returned last May and managed to start the 400,000-Btu aircraft heater, thawing the bulldozer so they could unearth the generator, mess tent, and other supplies left behind. In two feet of snow and temperatures around 20 degrees Fahrenheit, Greenamyer bled the brakes and plugged countless fuel and oil leaks.

"Today's the day," he announced on May 21, a clear and windless Sunday. Planning a high-speed taxi test, Greenamyer and *Kee Bird* roared to the end of a frozen lake, trailing hundred-foot-long rooster tails of snow, pivoted, and lined up with the impromptu runway. Then *Kee Bird* caught fire.

Shouting for a fire extinguisher, Greenamyer made a futile attempt to beat out the flames in the tail with a coat. Within minutes the tail had melted off; in hours the fuselage had melted as well, and the thick gray smoke was streaming into the sky through the night. The fire had been started by fuel that had spilled from a jury-rigged auxiliary generator in the rear of the aircraft that no one had thought to secure.

"It would have flown," Greenamyer said quietly. "I had elevator control. I got the nose up. It would have flown. This whole thing was made of improvisations and one of them failed. But how can you think of everything?"

(See the August 1995 issue of *Smithsonian* magazine for the detailed story of the salvage attempt.)

—Carl Hoffman

Airshow Japan

Last May, almost half a century after the last Zero flew in combat, 40,000 awed and curious Japanese trekked to Ryugasaki airport, an hour and a half northeast of Tokyo, to see their country's most famous warplane take to the air. A P-51D Mustang and a Pitts Special biplane also took part in the show, a major event for a country with no flyable World War II aircraft.

At last count, there were 33 Mitsubishi A6M Zeros around the world in various states of repair. Only two are airworthy, and only one is powered by its original Nakajima Sakae engine. A Nakajima-built A6M5, it wears the dark green paint and unit markings of the 261st Tora Kokutai (Tiger Group), which perished on Saipan and Guam in the summer of 1944. Like the Mustang and the crews that flew and maintained them, it was on loan from the Planes of Fame Museum of Chino, California.

The Pitts Special belonged to show organizer Takehisa "Ken" Ueno. But what the 32-year-old really wants is a Mustang. "The shape," he exclaims, "the design, and the sound of that engine!" In pursuit of that dream, Ueno visited Chino last year. The result was 40 hours of Mustang cockpit time and an agreement by museum members to fly their aircraft at the Ryugasaki airshow. (The next one, Ueno hopes, will feature his own Mustang, which the museum is helping him find.)

It will come as no surprise to U.S. trade negotiators that a major obstacle was getting the U.S. fighter certified by Japan's Civil Aviation Bureau. In the end,

WESTERN PACIFIC/TWENTIETH CENTURY FOX

America's favorite dysfunctional family, the Simpsons, is the latest addition to Western Pacific's flying billboards. The start-up regional airline, based in Colorado Springs, kicked off its Air Logo program by decorating one of its three 737s with the logo and colors of Colorado Springs' Broadmoor Hotel. "American aviation and American television are important parts of our culture," says president and CEO Ed Beauvais. "That's why a joint promotion—between Fox [Broadcasting] and Western Pacific—is very appropriate." As the show's Mr. Burns would say, "Excellent."

however, the bureau settled for viewing videotapes of the restoration and assembly process. Certifying the Zero went more smoothly, if only because it had visited Japan once before, in 1978.

What might surprise an American observer was the cost of a ticket to the three-airplane show: 3,000 yen, about $35.

—Daniel Ford and Scott T. Hards

It's All in the Wrist

A former test pilot at California's Edwards Air Force Base recently found himself carpally challenged when he attempted to demonstrate a flight maneuver with his hands. Pilots do that all the time, but this maneuver, which the X-31 had been practicing at Edwards and performed at the Paris Airshow last June to wild acclaim, proved easier said than done.

Recently, the big dog on the military airshow circuit has been the Russian Sukhoi Su-27 Flanker and its Cobra Maneuver. The monster Su-27 can stand on its Saturn engines, creeping forward, nose pointing nearly straight up. Fighter jocks know this gives the Su-27 the capability to suddenly point its guns straight at an opponent above it at essentially zero airspeed. Every pilot who might have to face a Flanker knows he should never, ever park directly above one.

But the X-31, a thrust-vectoring enhanced-maneuverability testbed built by a combined U.S.-German consortium (see "Stall Tactics," April/May 1991), can not only do its own Cobra but can then coil and strike up, down, and around from its tailstand. "The ability to vector your thrust means that the X-31 can be at zero knots airspeed, 70 degrees angle of attack, and still be able to smartly yaw around and keep an opponent in the pipper," says one knowledgeable observer. "I've seen footage of an F-16 in the X-31's crosshairs long enough to be shot down ten times, with the voice of the seemingly bored X-31 pilot going *bang-bang-bang-bang*."

The X-31 maneuver is called a J-turn. Limber up your wrist and follow through: You've just completed a head-on pass with your opponent. Do a rapid pullup, maintaining altitude rather than gaining it, but pulling the nose straight up. Attain a 70-degree nose-up attitude and continue pulling to about 15 degrees past the vertical. Then yaw (rotating your hand around a point through the palm) a full 180 degrees, until your "airplane" is pointing almost straight down. Now either pull out level and chase the other guy or roll level and disengage. The fighter pilot who can choose to fight or flee holds all the cards—though his wrist will get mighty sore showing you why.

—Stephan Wilkinson

CHARLIE ARCHAMBAULT

Boeing's 777 made its first commercial flight last June 7 in United Airlines livery, flying passengers from London's Heathrow Airport to Washington-Dulles International ("You Can Look But You Can't Touch," Apr./May 1994). Boeing says the $120 million airliner is highly fuel- and maintenance-efficient, but passengers were more interested in the amenities: more headroom, wider seats, and individual video screens.

Ex-Rated

Imagine you're an airline pilot who wants to impress your pilot buddies. Say you also have a friend who is accredited by the Federal Aviation Administration to sign pilots off on legendary aircraft like the B-17 Flying Fortress, the B-25 Mitchell, the Lockheed Constellation, or the Ford Trimotor—airplanes you could probably fly with complete safety. After paying to pilot one of these antiques for a couple of hours, would there be any harm in having your friend sign you off so the type rating is listed on your pilot's license, just to show your pals?

If the FAA ever finds out, you bet. After what Anthony Broderick, associate administrator for regulation and certification, called "one of the most comprehensive and thorough internal investigations in the history of this agency," the FAA has ferreted out 29 pilots, including six FAA employees, who Broderick says have "falsified flight records as a means of expanding the types of aircraft they were licensed to fly." In addition to the aforementioned vintage aircraft, unearned ratings were given for corporate jets and even a regional airline-class turboprop.

The investigation is still under way, but as of late June the FAA had revoked or suspended the certificates of four inspectors and removed them from assignments involving certifications; two others retired. Twenty-three other pilots and non-FAA examiners are under investigation.

The FAA will not reveal identities of any of the pilots or specifics of any of the cases. The agency will say that the incidents were not an organized effort in one part of the country but rather a number of unrelated occurrences that took place over several years and in many regions—but mostly on the west coast. In one scenario, a handful of pilot examiners flew one of the old airplanes, then signed one another off as qualified pilots. Typically three to 10 hours of training is required to prepare for a type-rating exam, the check ride for which runs from one to three hours.

Broderick emphasizes that although the FAA is making "several dramatic changes in the way this agency handles the aircraft type rating process," there were no accidents and no compromises in commercial passenger safety. In fact, there was no evidence that illegal licenses were issued for aircraft currently in use by airlines, or that any of the pilots involved used their ill-gotten ratings to fly any of the aircraft in question for commercial air carrier operations.

So what was the harm?

"These airmen have undermined the

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integrity of the FAA workforce," says Broderick. "Their actions are a slap in the face to the more than 48,000 dedicated employees who strive daily to ensure that the skies are safe."

—Phil Scott

The Price of Fame

Charles Lindbergh, who loathed public exposure, would have been appalled: a whole room full of *stuff*, hundreds of items emblazoned with his name or likeness, usually both. But perhaps he might have appreciated the reverence with which the items were displayed, discussed, swapped, and sold by the members of the C.A.L./N-X-211 Collectors Society at their annual symposium near Washington, D.C., last May.

LOGO DESIGN BY MORT KUFF

Following his 1927 solo flight from New York to Paris in the *Spirit of St. Louis*, Lindbergh became an international idol and the adulation triggered a frenzy of merchandising. After nearly 70 years the souvenirs have become collectibles. By preserving "the treasured pieces of this historical memorabilia," says Bob Arehart, the society's secretary, the group helps "perpetuate the memory of the man and the machine," the society's motto. Hence C.A.L. for the man, and N-X-211, the airplane's registration number, for the machine.

Though the display tables were loaded, the items there were only a fraction of the members' holdings, the list of which fills a 71-page catalog. There are busts, medals, lapel buttons, plates, pillow covers, tapestries, pocket knives, bookends, sheet music, ashtrays, letter openers, bracelets, rings, pencils, drinking glasses, poker chips, vials of Lucky Lindy Perfume ("The Essence of Luck"), the *Spirit of St. Louis* re-created as a music box and a coin bank ("The Spirit of Thrift"), and Lindbergh statuettes as liquor decanters. The collectibles say as much about the pervasiveness of American marketing as about the pioneering spirit of 1920s aviation.

About a quarter of the society's 199 members were at the symposium, which is held on the anniversary of the 1927 flight. There was Irene Brostow, born on the very day Lindbergh took off for Paris, who named her daughter Linda. Jim Morris, wearing a belt his wife had decorated with needlepoint icons associated with the flight—the Statue of Liberty, a globe, a compass, the Eiffel Tower—closed a symposium session with a recitation from Lindbergh's memoir of the flight. But the most spectacular gesture was represented by a photo of member Scotty Lowe's back, the length and breadth of which is adorned with a tattoo portrait of Lindbergh in helmet and goggles.

Members harbor no illusions about their collections—they're happy to point out tacky items, perhaps because kitsch has its own odd charm. "There's always a market for junk," says Arehart. But some pieces that appear inconsequential have become quite valuable due to their age and rarity. One wooden pedal-powered *Spirit of St. Louis* toy is valued at $1,800.

The most venerated display item was an engraved sterling silver box, one of nine that Lindbergh gave to each of his financial backers on the 10th anniversary of the 1927 flight. This one had been presented to Frank Robertson, who, with his brother, had recruited the other St. Louis businessmen. Before the flight, Lindbergh had been chief pilot for Robertson Aircraft, flying the St. Louis-Chicago airmail route.

Robertson's son Frank, a society member who had brought the box to the symposium, read to the rapt group from a letter Lindbergh had written to his father: "When I think of the planes we flew and of the difficulty we all had in making a living from aviation, it seems to me that...the character of men, in those days, was almost a structural part of their aircraft, and that the strength in one combined with the weakness in the other to make flying possible."

—Lester A. Reingold

Ryan historian Ev Cassagneres is writing a book on the Spirit of St. Louis *and would like to hear from readers who had any contact with the Ryan monoplane or its pilot during Lindbergh's 1927-1928 goodwill tours. Contact him at 430 Budding Ridge, Cheshire, CT 06410; phone (203) 272-2127.*

That Old Black Magic

When Abe Kardong ran over a black cat on a Friday the 13th in 1968, he knew it meant trouble. Less than a month later, his brand-new Air Force SR-71 Blackbird shattered a wheel rim on takeoff at California's Beale Air Force Base. Kardong stayed with the aircraft as it veered off the runway and crashed, but his reconnaissance systems officer, Major Jim Kogler, ejected. What Kardong remembers most after climbing out of the burning airplane to help Kogler as he parachuted down is the reaction of his six-foot, five-inch backseater: "I always wondered if my knees would clear the instrument panel."

Last June, 40 years after the first flight of the U-2 and more than 30 years after the A-12 and SR-71 appeared, Kardong and other Lockheed reconnaissance aircraft pilots and crewmen met in Sparks, Nevada, for their biennial reunion. There was much rejoicing that after a five-year retirement, the SR-71 is being brought back into limited service. The Air Force, under Congressional pressure, is reactivating two Blackbirds, and just the day before, reported Lockheed Martin SR-71 project manager Jay Murphy, one of them had reached Mach 3.3. The smaller, slower U-2 and its TR-1 offspring have continued to monitor world trouble spots as well as U.S. earthquake and flood damage.

Ken Collins was one of the first Blackbird pilots—and survivors. On May 24, 1963, his supersecret A-12 went into an inverted flat spin near Wendover, Utah. Ejecting upside down, he landed safely in the desolate countryside and was discovered by three men in a pickup. "I told them I'd crashed an F-105 with a nuclear device on board," he says. Their reaction was 'We're gettin' outta here. You wanna go with us?' "

Some of the Blackbird

MARK AVINO

alums' memories were less exotic or fraught with danger but equally rich. As he once aimed his SR-71 east over the Atlantic, recalls Rich Graham, "the sun came up directly over the nose. Then I popped the periscope and saw a full moon perfectly centered between the afterburners behind me. It was a Kodak moment you couldn't have captured on film."

Former U-2 and SR-71 pilot Pat Halloran summed up the group's elation that the SR-71—"the Sled"—was back in the air. "At Beale," he told the closing night banquet crowd of 600, "someone had written on the nose section of an SR-71, 'Elvis is dead and so is The Sled.' Someone recently scratched it out and wrote, 'Elvis lives.' "

—Bob McCafferty

The Birthplace of Astronauts

"We've had more astronauts from Cleveland than any other city on the planet Earth, if you look at the numbers," boasted Don Thomas, a member of the first all-Ohio crew since John Glenn's voyage in 1962.

Glenn, the first American in orbit, was born in Cambridge. Neil Armstrong came from Wapakoneta. Over the years, NASA documents show, 15 other astronauts have called Ohio home, including four of the five assigned to shuttle *Discovery* on a satellite delivery mission poised to fly last July.

Commander Tom Henricks is a native of Woodville. Mission specialists Thomas and Mary Ellen Weber are from Cleveland. Flight engineer Nancy Sherlock Currie was eight when her family moved to Troy. To make it unanimous, Thomas persuaded Ohio governor George Voinovich to proclaim pilot Kevin Kregel, a New Yorker, an honorary citizen of the Buckeye State. "I went to school in Colorado, so I had to drive through Ohio back and forth," says Kregel. "I guess that's my connection."

The crew's suitcases were stuffed with mementos from home—Ohio flags, a college pennant, a school T-shirt, a key to the city of Toledo, even Cleveland stadium mustard. Strangely, there was no buckeye, the horse chestnut that gave the state its nickname. "I suspect we'll have a buckeye on the flight," Henricks said last May, two weeks before fate provided some extra time to correct the omission. A pair of nesting woodpeckers poked nearly 200 holes in the insulation on *Discovery*'s fuel tank, forcing a five-week delay and bumping *Atlantis* to the head of the line.

"They're Ohioans. They'll bounce back," said *Atlantis* flight engineer Greg Harbaugh, a native of Willoughby.

—Beth Dickey

A Boy and His Camera

On a spring day in 1904, the families strolling among the dunes at the seaside town of Merlimont, France, came across a strange sight. At the top of a dune, a man lying inside what appeared to be an enormous kite was attempting to soar through the air. His first try was unsuccessful, but on his second attempt he flew 80 feet. The man inside the glider was Gabriel Voisin (who would become a leading figure in the French aviation industry), and he had just completed France's first glider flight.

Lartigue (at age 22, left) captured many scenes with his camera. Below, from left to right: playing with a kite at the family's country home in Rouzat, 1911; Gabriel Voisin's glider flight, 1904; righting a Farman biplane, 1922; a dirigible in Sartrouville, 1907 (opposite, above).

Among the spectators was 10-year-old Jacques-Henri Lartigue, who had been collecting seashells with his well-to-do family. When Jacques-Henri was seven, his father had given him his first camera, and on that day at the shore he happened to have one in tow. As Lartigue later wrote in his diary: "I was lucky enough to witness the first successful public plane flight ever held in France. With a beating heart, I pressed the shutter."

It was Lartigue's first aviation photograph, one of a thousand such pictures he would take in his early years. Balloons, dirigibles, winged bicycles, kites, powered airplanes, and the men who flew them—all were fair game for the curious youngster. Lartigue's photographs give us "a child's-eye view," says Allan Janus, a National Air and Space Museum archivist and a photographer in his own right. "They capture a child's

ASSOCIATION DES AMIS DE JACQUES-HENRI LARTIGUE/COURTESY AFA (5)

wonder at all these incredible things that were going on around him."

On September 30, the Museum will open "Flights of Fancy: Photographs by Jacques-Henri Lartigue, 1904–1922." Drawn from the collection of the Paris-based Association des Amis de Jacques-Henri Lartigue, the exhibit features 84 modern prints that will be on display through March 1, 1996.

Besides revealing the young photographer's surprisingly sophisticated eye, the collection is notable for evoking beloved moments in aviation history and for capturing the motion of flight itself. "The photographs we have of aviation before [this period] were very static—balloons hovering, balloons being filled," says Janus. Because Lartigue used a hand-held camera that could take very fast exposures, he was able to capture the movement of objects through the air. "He was fortunate in being able to take up photography at a time when finally it was so easy a child could do it," says Janus. "So [the collection] is a really nice conjunction of this time in both photographic and aviation history. And all brought together by a little boy."

—Diane Tedeschi

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700 Mon.–Sat., 9 a.m.–4 p.m.; TTY: (202) 357-1729.

Summer Hours Through September 4, the Museum will be open from 10:00 a.m. to 6:30 p.m.

August 5 Monthly Sky Lecture. "The Origin of the Moons of Mars." Robert A. Craddock of the Museum's Center for Earth and Planetary Studies will discuss the possible origins of Phobos and Deimos. Einstein Planetarium, 9:30 a.m.

August 19 Family Star Watch. "The Summer Sky." Join Cheryl Bauer of the Einstein Planetarium as she takes you on a starlit journey through the summer sky. Einstein Planetarium, 10:00 a.m.

Live Music The U.S. Navy Commodores, a jazz ensemble, will entertain visitors with noontime concerts in the Air Transportation gallery on August 4, 11, 25, and September 1 and 8.

Museum Visits For a free planning packet, write Smithsonian Information, Smithsonian Institution, Washington, DC 20560 or call (202) 357-2700. Daytime parking near the museums is limited; visitors are urged to use Metrorail.

ARTIFACTS

JERRY McCREA

In May the Museum received a Corona satellite camera from the CIA, which had declassified the object in February. Starting in 1960, the Corona program deployed the United States' first photo-reconnaissance satellites, which gathered intelligence about the Soviet Union and its allies during the cold war. The Lockheed-built satellites carried an Itek-designed 70-degree panoramic camera. The film, ejected from the satellite in a parachute-equipped capsule, was snatched midair by an Air Force transport. By the time the Corona program ended in 1972, its cameras had photographed all Soviet missile complexes and submarine classes. The Museum's camera will be part of a new exhibit opening next year entitled "The Space Race."

The Mars Paint-by-Number Set

Before July 15, 1965, it was intellectually possible to suppose that Mars might be more like Earth than like the moon. It was still respectable—though just barely—to conjecture that what Percival Lowell had seen through his telescope in 1894 were channels carrying water, if not exactly canals, and that Ray Bradbury's Martian villages could exist, at least in the imagination, alongside the giant oxygen-producing cabbages and three-legged Martians of Robert Heinlein's novels. Mars, after all, had polar caps (which behaved much like frozen water), green areas that came and went with spring and fall, and, by a lucky accident, a rotation rate almost the same as that of our own planet.

At the Jet Propulsion Laboratory in California, which built and operated the Mariner 4 spacecraft that was swooping by Mars on that day, most people's eyes were on the single experiment everybody hoped to understand: the return of the first picture of another planet from a space probe only a few thousand kilometers above its surface. The press, too, was focused on the pictures, eager to have something for the evening news.

As a physics graduate student working for the summer at JPL, I had the opportunity to hang out in the Space Flight Operations Facility (SFOF) control room through much of the day of the encounter. No reporters were allowed there; few JPL staff members got to walk around unmolested either. Perhaps I had an innocent face.

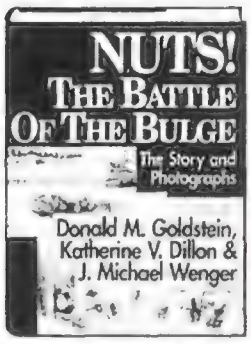
The imaging science team, however, embargoed all versions of the photo data until the scientists had processed the information and made their first analyses. Even the engineers in the SFOF were cautioned not to try to make an image out of the data they used to monitor the spacecraft's orbit of Mars. The prohibition was so strict that engineers at the South African ground station where the data would be received were given the same warning. Of course, it would be impossible to stop a bunch of wily engineers who had worked 12-hour days and seven-day weeks for nine months during Mariner's voyage from getting a first peek at the high point of the flight. Therein lies a tale of bureaucracy, determination, and creativity.

All pictures from space are transmitted in digital form. The image is broken down into square picture elements, called pixels, of varying brightness. (Television news shows sometimes use large pixels to obscure the face of a subject.) Today, the pixels in space images are based on brightness values between zero and 256. An IBM-compatible computer's "VGA" color display uses exactly the same system. Mariner 4, however, used a black-and-white TV camera, and each pixel ranged from zero to 63. Each computer pixel today is based on eight bits of information: Mariner's picture data were limited to six bits (the other two were used for engineering purposes).

Today an image can be transmitted

Although it shows northern Mars, the chalk image was completed the way the data arrived: upside down. The computer-corrected version appears at top; when released to the press it showed the black arc of space on top.

ENGAGE THE BEST



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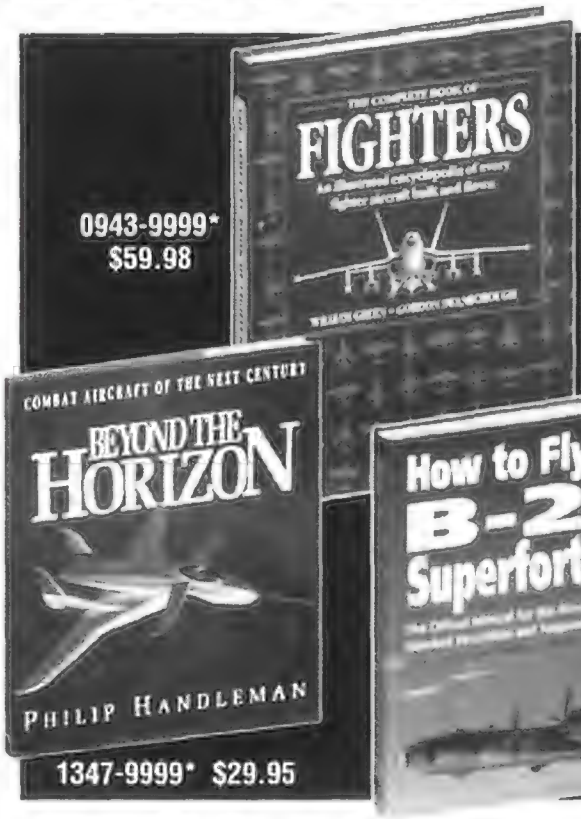

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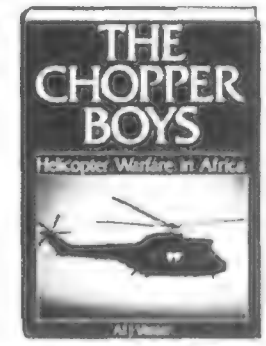

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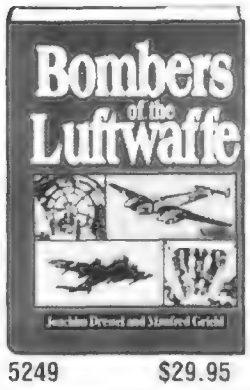

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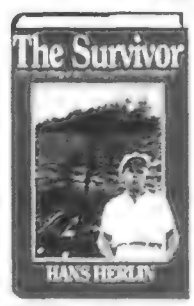

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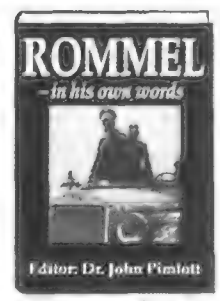

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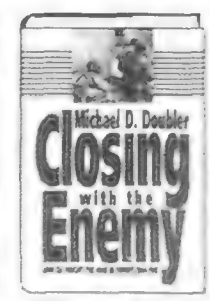

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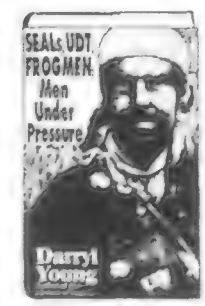

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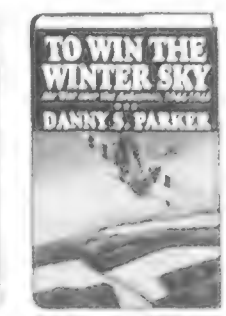

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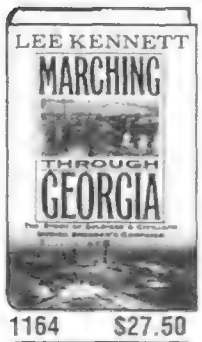

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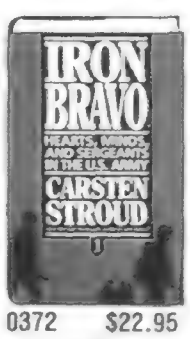

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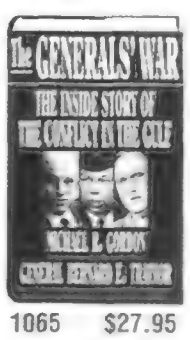

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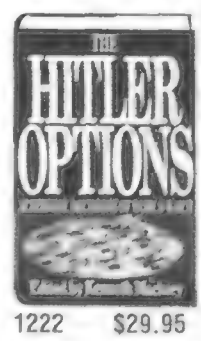

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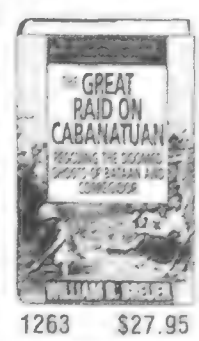

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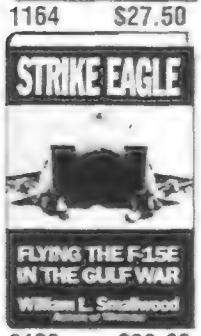

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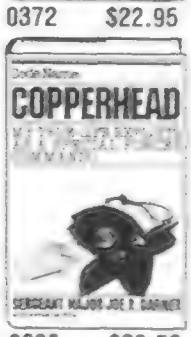

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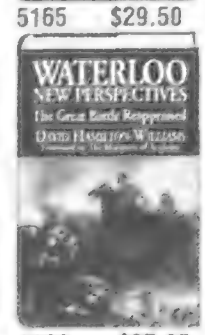

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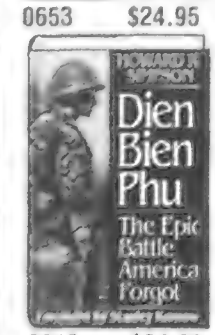

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A day after its near-miss with demolition, the drawing was presented to JPL director William Pickering (center).

from a spacecraft at the distance of Mars in almost real time; in 1965 Mariner could send back only 8.3 bits per second. Since the Mariner picture was made up of 200 scan lines, each with 200 pixels, a total of 40,000 individual numbers needed to be transmitted to Earth. The first picture would not be complete until more than 10 hours after playback of the space probe's tape recorder began.

The night before the encounter it occurred to some engineer that since only one pixel would be received each second, the data could be decoded, passed to an adding machine printer called a "ritty-ditty" (the acronym was RITY-DITY, but nobody seems to remember what it stood for), and typed out three digits wide, producing a data stream that looked like

051
049
044

as the brightness of the picture changed.

The adding machine tape could be cut off after every scan line, glued to a bulletin board, and then colored by hand. Sixty-four shades were too many to handle, but 64 divides neatly into eight groups. So the engineers surreptitiously bought eight boxes of artists' chalk in a spectrum ranging from black to white, with one shade of gray and the rest in warm tones from rust to yellow—the colors of the "Red Planet."

It was a good match of electronic capabilities, human abilities, and the average attention span. If the picture had come in ten times faster, nobody could have kept up with the coloring; had it come in only a tenth as fast, watching the picture build up would have been about as much fun as watching paint dry. In fact, the process was almost hypnotic, for a new scan line of 200 pixels was received about every three minutes, snatched from the printer, and stuck to the bulletin board, where it was promptly colored in by JPL engineer Richard Grumm and others. The first picture returned from another planet was to be revealed by a paint-by-number set.

The control room was very quiet as the first few lines were colored in. Except for the black border marking the edge of the picture, each line was "dark brown" and featureless from end to end. Had the intricate space probe and its camera somehow failed? Was the camera pointed away from the planet? After nine months of cruising to Mars, was it possible that Mariner would send back nothing but pictures of empty space? It was possible, because Mariner 4 relied on observations of the Southern Hemisphere star Canopus to tell it which way was up. And the sensor that tracked Canopus had been having problems throughout the entire mission.

After half an hour the crowd got some relief when the last few pixels of one scan line produced a color just a little bit brighter than "brown." Nothing recognizable as the surface of a planet showed up at first, but at least there was evidence that the camera was properly aimed and functioning. Over the course of the day the picture in the SFOF built up. The dark of space yielded to a thin arc of atmospheric haze, and beneath the haze the solid sphere of Mars took shape.

Despite the embargo on pictures, word that the image was taking shape had spread around JPL. Small groups of staffers were admitted to the rear of the room for a quick look, three minutes or so, and then moved out, but for some reason I was allowed to leave, go back to my work designing a rocket-braked maneuver for landing a probe on Mars, and then return when I liked. And I liked, at least once every hour. However, the comings and goings of JPL employees did not escape the notice of one scientist, who stormed into the control room to demand that the engineers stop their work on the picture, and that the laboratory fire those responsible for "stealing" the data. The engineering staff ignored him.

Coloring continued into the evening, when at last the scene was complete. Even then, the first picture of Mars was not safe; from the science room came word that it was to be destroyed before dawn. The control room chief disagreed: He sent in his assistant, a former Marine named Earl Smith, equipped with a saw. With four strokes the chalk drawing and its backing were severed from the bulletin board on which they were mounted (some remember that Smitty cut it off the wall of the building, but I contend the picture had been glued to a bulletin board) and carried away. The carpentry shop was awakened, and long before morning the first picture of Mars had been placed in a custom frame with an engraved brass plaque.

Early the next day, the director of JPL, William Pickering, was invited to the lobby of the SFOF, where, as flashbulbs went off and TV news cameras rolled, the paint-by-number drawing was presented to him. Preserved by what was, in essence, a bureaucratic end run, the first picture of Mars was destined to spend the next 15 years hanging in the director's suite of offices.

Back in the image laboratory, Bruce Murray, then a junior scientist but later to succeed Pickering as JPL director, was carefully studying the first three computer-processed pictures from Mariner. The sun's angle was terrible and the pictures low in contrast, but suddenly he recognized that a smudge in the corner of one frame also appeared on the edge of another. When the two pictures were overlapped, he realized he was looking at craters.

Later images were clearer, and by then our new image of Mars was as well: To the disappointment of many, it was evident that the planet resembled not Earth so much as the moon.

By the end of summer the results of another Mariner experiment had shown that the density of Mars' atmosphere is half a percent that of Earth's. That was just thick enough to permit a parachute-assisted landing—an enormous savings in complicated rocketry. My project wound up on the same Martian scrap heap as Lowell's canals, Bradbury's villages, and Heinlein's cabbages.

The first picture, over the years, fared a bit better. It left the director's suite to go on loan to a museum for a year and was replaced by a spectacular view of the Martian surface sent back by one of the Viking landers. The chalk image was returned to the SFOF building where it was born, to be hung in a dark and almost inaccessible corner. Finally, last March, the picture was called out of obscurity to appear in a JPL "Mars Day" celebration. Today, it hangs in a corridor of public affairs offices.

—Peter D. Zimmerman

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The Rockets' Red Glare

In 1957 Sputnik hit the nation like a slap in the face. The Soviets' launch of heavy payloads showed that nuclear warheads could be fired at any place in the United States. We had to catch up.

My father was then an Air Force captain, one of the crew charged with turning experiments at Cape Canaveral into operational weapons. The Pentagon had chosen a new facility for the effort: Camp Cooke, an old Army tank training station in California near the town of Lompoc. The first big missile launched from what would become the Vandenberg advanced missile launch complex was a Thor, the system my father was trained to operate.

In 1958 Vandenberg was mostly wood and tarpaper buildings slathered with new paint. The junior high I attended was a series of low buildings connected by what seemed like miles of wooden walkways, part of what had been the Army post hospital.

Though the setting was drab, every couple of weeks the center would come alive. As we sat in Biology or Algebra, we'd hear a low rumbling that seemed to come from all directions. As it grew impossibly louder, it began to ascend. By then all of us had rushed outside to watch the bright flame climb into the cloudless Pacific sky, drawing its vast roar with it. We always hoped the launch would be successful, that our fathers would come home that evening flushed with success. But often the range safety officer would have to destroy the rocket to keep it from tumbling off course toward some populated area. The thunder would turn into a hollow explosion, and the fire in the sky was abruptly replaced by a small white cloud. We'd glumly return to class. Sometimes the failures were caused by what seemed like insignificant details. Dad told me about two small pieces of hardware—"programmer liftoff pins"—inserted at the base of the Thor that activated certain switches controlling the missile's guidance programs. During launch, the movement of the missile automatically removed the pins, which triggered the switches. But after one pre-launch test, someone neglected to properly reset the pins. They went up with the rocket. Rather than performing the standard roll and pitchover after liftoff, the Thor rose straight up. This was not a good sign. The range safety officer detonated the errant rocket at 150,000 feet.

Some missiles never made it off the pad. As we drove to the beach one weekend, Dad noticed that one of the Thors he had worked on was erect on the pad as if ready for launch. It turned out the civilian contractors had erected and fueled the missile as part of their tests. After such testings, a complete purge of all the rocket's internal plumbing was required; otherwise, at ignition, the volatile liquid oxygen within the rocket could prematurely ignite fuel remaining in the system, causing an explosion. The contractors said they had done a "quick and dirty" purge—they were in a hurry to complete their work, turn the Thor over to Air Force supervision, and get paid. During the subsequent static-fire test, in which the engine is fired but the missile remains on the launch mount, a huge explosion shot debris into a liquid oxygen tank, causing another explosion and a fire that pretty much totalled every piece of equipment on the pad.

In another incident, a design flaw brought the whole assembly to a grinding halt—literally. A Thor was being hydraulically erected when part of the upper launch mount, which moves with the missile, jammed against the lower launch mount, which is fixed to the pad. "The hydraulic motor didn't stop," Dad later told me. The erecting system brought the Thor to the vertical and then some—it bent the rocket right between the fuel and oxidizer tanks. "We created a hangar queen," Dad said. That particular Thor later became a display at base headquarters.

By 1960 the early frustrations were history. Most of the Thors were launched without incident; the occasional hollow explosions in the California sky now belonged to the Atlas and Titan tests. In one nighttime Titan I disaster, a missile being fueled with liquid oxygen and kerosene slipped from its launch elevator and careened into its silo, where it exploded. It looked like a giant, blinding searchlight flashing through our house's rear windows. An enormous clapping sound followed seconds later. Dad told me that the site's eight-ton silo doors had been thrown several hundred feet by the blast. The test facility was so badly damaged it was never repaired.

Eventually Dad was promoted and we moved to Texas. He returned to Vandenberg in the early 1980s as a manager for the space shuttle program. Now retired, he often talks about the differences between the frantic early days of the Thor and the computerized programs that ran the shuttle tests. As for me, I wonder if the kids living near Vandenberg today still tumble from their classrooms to watch the Deltas and Titans go up. I hope so.

—Kip D. Cassino

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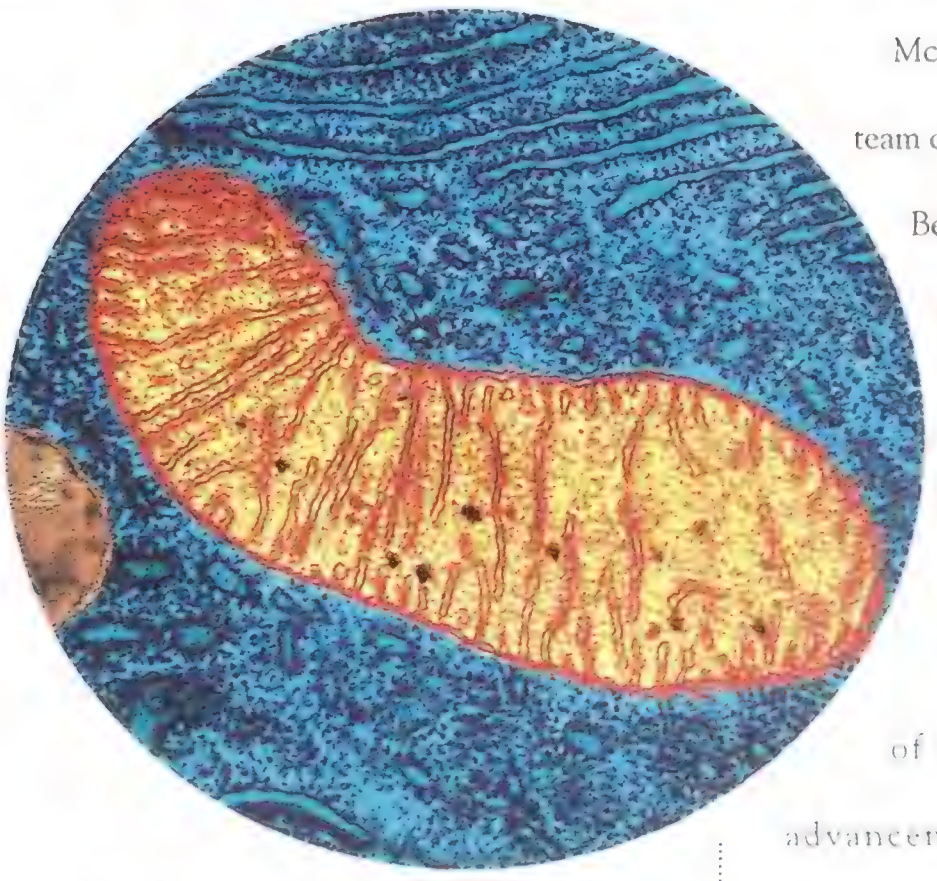
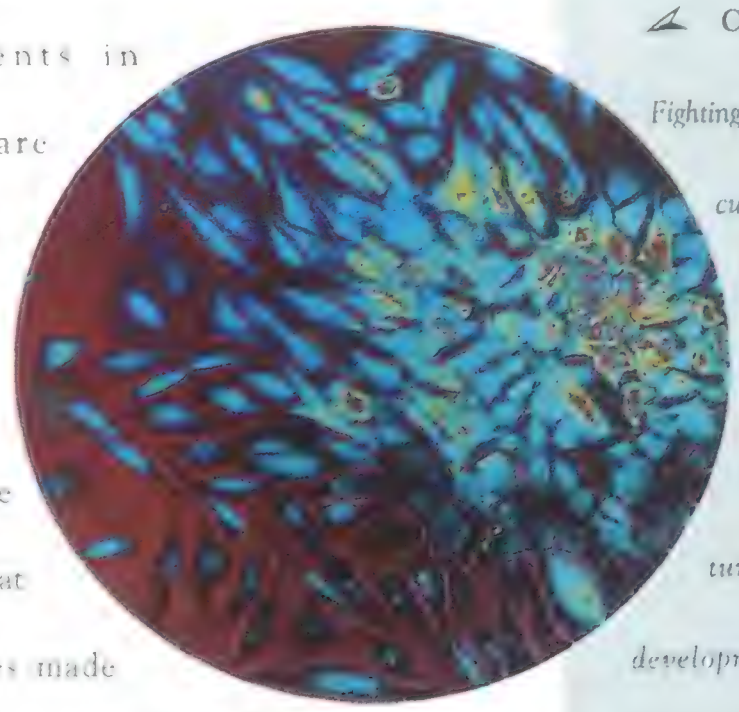


At McDonnell Douglas, we have been actively involved in space exploration for over 35 years. This has enabled scientists to research diseases like cancer, diabetes and immune deficiencies - making discoveries in space that could not have been made on earth.

McDonnell Douglas is now part of the team developing a space-based laboratory. Because the Space Station provides a unique, zero gravity environment, it can be used for new methods of medical research and lead to significant discoveries.

The Space Station is just one of the ways we are furthering advancements in space. We are dedicated to projects such as these because we know that discoveries made in space are really about improving life here on earth.

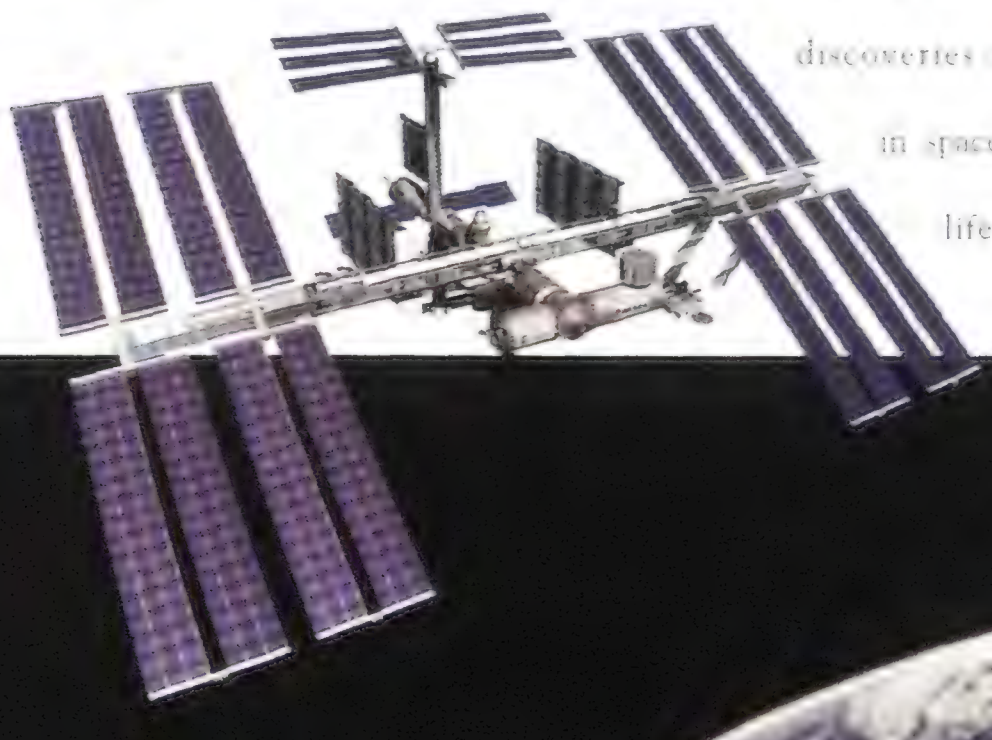


➤ ***Space Station Research.***

The effects of gravity on the development of the human cell (at left) are absent in space. This allows scientists to explore human physiological functions in new ways and gain insights into a wide variety of diseases.

➤ ***Cancer Cells***

Fighting cancer has been difficult. But space provides an ideal environment for growing protein crystals which, in turn, may lead to the development of tailor-made drugs for the treatment of cancer and other diseases.



MCDONNELL DOUGLAS

When time is of the essence, astronomers find that help is only a phone call—or an e-mail—away.

LOOK! UP IN THE SKY!

by Tony Reichhardt

Illustrations by David Peters

The call could come at any time, on any night, so Jack Brooks stays ready. He sleeps within earshot of his beeper, clothes ready for grabbing. In his backyard observatory, the camera with the CCD (charge-coupled device) sensor is cooled and primed for action, the computer always on. All he needs to do is flick on the monitor, roll back the roof, punch a button, and start taking images.

How long would the drill take? He's not sure—the few times he's gotten a call, it's been too cloudy to observe. But

if it ever happens on a clear night, he's pretty certain he'd be running those last 150 feet from his back door to the telescope. "Oh, yeah," he says. "Every second is important."

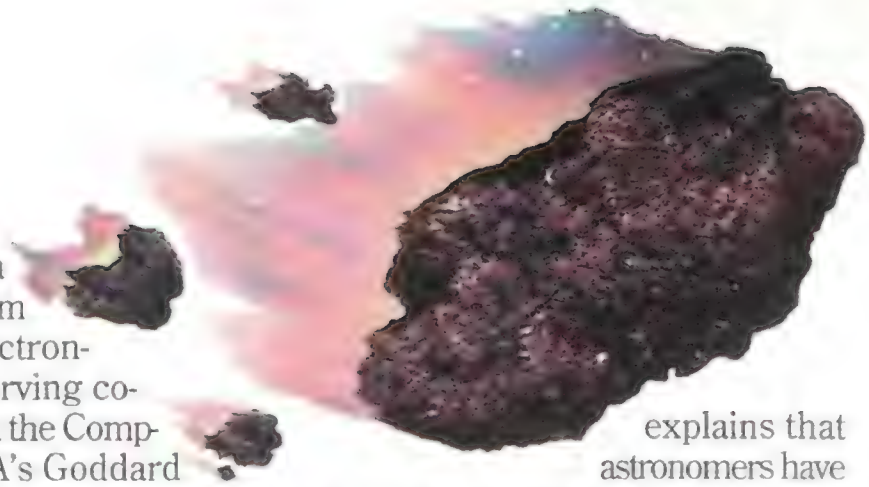
Brooks, a retired aerospace worker and amateur astronomer in Santa Ynez, California, is part of a small network of observers hunting some of the most elusive game in the night sky—the visible light (if any exists) of gamma ray bursts, high-energy flashes that have mystified astronomical theorists since they were discovered in the 1960s (see "The Great Gamma Ray Mystery," June/July 1993). NASA's Compton Gamma Ray Observatory spacecraft detects an average of one a day as it orbits Earth. Randomly distributed throughout the sky, the bursts can last anywhere from a fraction of a second to, in one case, apparently more than an hour. But they never happen in the same spot twice, and no observer has ever seen a counterpart in visible light or any other wavelength. It's as if there's nothing there—just a fantastic flash of gamma rays that appears out of the darkness and just as suddenly disappears.

Finding a counterpart for a GRB would be one of astronomy's great prizes, and more than three dozen instruments around the world are poised to search at a moment's notice. Together they make up a network called BACODINE (BATSE Coordinates Distribution Network), named for the instrument on board Compton that detects bursts. Jack Brooks and the six other members of the Santa Barbara Astronomy Group are the only amateurs in this exclusive network. If a GRB were to flare up some night in a part of the sky visible from southern California, an electronic mail message with observing coordinates would be sent from the Compton control center at NASA's Goddard Space Flight Center in Maryland to a satellite paging system, and from there to Brooks' beeper. Total elapsed time, from gamma rays hitting the spacecraft to Brooks hitting his telescope: about five minutes.

Impressive, sure, but it's glacially slow compared to the GROCSE (GRB Optical Counterpart Search Experiment) instrument at the Lawrence Livermore National Laboratory in California. This fully automated telescope, an orphan from a canceled "Star Wars" research project, is now devoted solely to responding rapidly to gamma ray bursts. A superfast Internet "socket" connection hooked to the telescope receives viewing coordinates directly from the BACODINE computer at Goddard. No human ever enters the loop. GROCSE starts taking pictures automatically, then stores them so scientists can review the data when they come to work the next morning. Total elapsed time, from gamma rays hitting Compton's detectors in Earth orbit to the GROCSE telescope, sitting in a parking lot at Livermore, automatically slewing to track its target: about nine to ten seconds. And four of those seconds are eaten up by the satellite transfer of the message.

Until a second-generation instrument takes over this fall, GROCSE will remain the fastest gun in town, though it too has come up empty in the search for a counterpart.

Even astronomers who don't need their information at warp speed find that electronic networks are useful to alert one another about cosmic events, whether it's a newly discovered comet, an asteroid whizzing past Earth, or a star going nova. Mike A'Hearn of the University of Maryland, who helped set up an e-mail network last year for scientists following the rapidly changing events resulting from Comet Shoemaker-Levy 9's collision with Jupiter,



explains that astronomers have to rely on the speed of electronic networks. "We don't do experiments," he says. "We're in the position of having God do experiments, and we get to look. So we need to be told to look at the right time."

Occasionally even spacecraft are pressed into service. By chance, NASA's Galileo spacecraft, en route to Jupiter, had the only direct view of the Shoemaker-Levy impacts. Project scientists reprogrammed it to take a few precious pictures at crucial moments, which yielded unique information. In 1986, the Pioneer Venus spacecraft was briefly diverted from its main mission to sneak a peak at Comet Halley as that body neared the planet. And the Hubble Space Telescope is always on call to interrupt its viewing program should something unexpected like a comet or a nova appear in the heavens. However, it takes up to 24 hours to interrupt the Hubble's scheduled observations—and that's done only for scientific operations that are likely to yield concrete results.

Astronomical observation hasn't always been so frantic. Nineteenth century astronomers did just fine leisurely reporting comet or asteroid discoveries in the German journal *Astronomische Nachrichten* (Astronomical News). But by the 1920s the pace of discoveries had picked up, and new communications technologies were coming on the scene. The official reporting venue for astronomical discoveries became the International Astronomical Union's Central Bureau for Astronomical Telegrams in Copenhagen, Denmark. In 1964, the bureau moved to the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, where it still resides. The keeper of the archive for 27 of the 31 years since then has been British-born astronomer Brian Marsden. If anything noteworthy happens in the heavens, chances are Marsden will be among the first people on the planet to hear about it.

Sometimes even if it isn't noteworthy he hears about it. Along with re-

ports from professional astronomers, which come in daily, Marsden hears from lots of amateurs who think they've found a new supernova or comet, which more often than not turns out to be a known object, or an artifact of the detector, or nothing at all. Some of the observers can be quite persistent, like "the annoying Dane" who sent so many faxes he jammed up the Bureau's machine. The man had made a simple observing error, and finally Marsden asked a Danish astronomer friend to explain to the observer what his mistake was. "When we try and intimate to them that they are deluded, well, it can get rather difficult," Marsden says with characteristic good humor.

Mostly, though, Marsden receives routine reports of comets, novas, and asteroids and follows up information on orbital parameters and the like. He waits for confirmation, and if the report checks out, he sends a notice to the rest of the astronomical community. The "circulars," as they're called, are, in the astronomy world, the official announcement of discovery.

The IAU circulars have traditionally gone out as postcards, but now many people get them by e-mail. Most astronomers report their discoveries that way too. Marsden doesn't recommend faxing, because he and his two colleagues at the Bureau don't check their machine regularly enough. Ditto the phone. "The problem with the telephone is you can't always get through, and we don't man the phones 168 hours a week," he explains. More importantly, e-mail messages don't need to be retyped, saving time and probably mistakes.

Given the unpredictability and suddenness of astronomical events, you'd think Marsden would be continually getting yanked out of bed at all hours. Not so. "I've never had a useful phone call in the middle of the night, in all these years," he says, emphasizing the word "useful." He can think of only one case where it would have been warranted. In 1987, several observers almost simultaneously reported one of the most celebrated astronomical events of our century—a bright supernova in the nearby Large Magellanic Cloud galaxy. In those first few hectic hours, reports were coming in from around the world. But the observers in Chile who had actually been the first to see the supernova, Ian Shelton and Oscar Duhalde, weren't able to phone in their sighting. Afterward, it took some effort to sort out the different reports and give Shelton and Duhalde, along with Albert Jones in New Zealand, credit for the discovery.

"This was the one occasion where it would have been useful if they had called me at half past four in the morning," says Marsden.

It was the pace of events surrounding Supernova 1987a, along with the maturing of e-mail technology, that convinced many astronomers they should hook up to the Internet to speed communications. Like gamma ray bursts, novas and supernovas go off without warning, and time is of the essence. Some of the most interesting physics take place soon after the explosion is detected, when the supernova is still "rising." Within a matter of days, the exploding star can cool from hundreds of thousands of degrees to only tens of thousands. Along the way it passes through various ionization stages, which tell theorists much about the mechanisms of the explosion. During this rapid cooling, the ultraviolet brightness can drop by a factor of a thousand or more.

Knowing that the ultraviolet fireworks wouldn't last long, NASA allowed a team led by Harvard supernova expert Robert Kirshner to commandeer the orbiting International Ultraviolet Explorer for a few key observations just after 1987a exploded. Their quick response gave scientists their most detailed look yet at the immediate aftermath of a nearby supernova.

"I've never had a useful phone call in the middle of the night, in all these years."

Brian Marsden

The premium on quick response prompted Sumner Starrfield of Arizona State University to create what he calls the Nova Network last year. He set it up as an "exploder," meaning that e-mail messages sent to that address are automatically forwarded to everyone on the network—a kind of instantaneous heads-up alert. About 170 people are now on the network, which has a single, specific purpose. No theory, no chat—just a quick alert when people find, or think they find, an exploding star.

Besides its speed, the great advantage of an exploder system is that no human has to get involved in spreading the word. In the past, says Starrfield, he used to run up "unbelievable phone bills" letting colleagues know about a discovery and then staying on the line longer than he'd planned.

The network that Mike A'Hearn and his colleagues at the University of Maryland set up for last summer's impact of Comet Shoemaker-Levy 9 with Jupiter was an exploder. At one time, a couple of hundred people were on the network, trading news from viewing sites around the world. A separate electronic bulletin board was

used for posting scientific results, including images.

Scientists often have some of their best discussions in the hallways at meetings, and the Shoemaker-Levy 9 networks became a giant worldwide hallway for trading ideas, insights, and even data. Stephen Maran, a NASA astronomer who also coordinates press activities for the American Astronomical Society, says: "I have never seen professional astronomers share raw observations like that before." He thinks networks like the one created for SL-9 will lead to a more open, collegial climate for scientists working on specific topics. "I think it will have a permanent influence on the way astronomers do things."

Not that exploders don't pose their own problems. Tom Gehrels, who searches for earth-crossing asteroids at the University of Arizona, doesn't see much use for an exploder, since only a limited number of individuals and instruments can spot the dim objects for which he searches (see "This Target Earth," Oct./Nov. 1991). Any kind of exploder network would be, in essence, overkill. "That's about the last thing I need," says Gehrels, who worries that an exploder network would lead to the equivalent of astronomical junk mail.

Starrfield agrees that with e-mail networks, everyone has to understand the rules and limitations. When the information isn't edited or verified, there is always the danger of false alarms. Normally, astronomers like to have confirmation before they call an alert. But on the Nova Network, where speed matters, the philosophy is, "If you see something, there's no embarrassment. Put a report out and let someone check it."

Marsden also thinks the Nova Network is valuable, but he still worries. He recalls the "nasty fiasco" of a supernova reported in the Andromeda galaxy a few years back. Even though the report was wrong, many astronomers believed it. Observers were pulled away from world-class telescopes, which are booked months in advance, to free the instruments to search for the supernova. Marsden remembers one prominent astronomer driving three hours to California's Palomar Observatory, only to have to turn around and go home.

Alex Filippenko, a supernova expert at the University of California at Berkeley, agrees that scientists have to be careful about crying wolf. He runs an automated search for supernovas, using a telescope that looks for sudden rises in brightness in hundreds of galaxies. Each night the computer finds about a dozen events that warrant closer inspection. Usually they turn out to be nothing. If astronomers were alerted to all of these events, it would be a "completely unacceptable false alarm rate," says Filippenko. "I bet the novelty for most people would wear off pretty quickly."

Eventually, he thinks, there will be a fully automated system that can evaluate each alarm and send out an e-mail alert only if there's a good chance of it being a supernova. But that won't happen until computers can approximate all of the kinds of judgments astronomers make, an achievement he says is "amazingly difficult."

Meanwhile, at Brian Marsden's office in Cambridge, the reports keep dribbling in. A lot of one-time-only observations, particularly supposed asteroid sightings, never get confirmed or followed up. "We put our foot down a few years ago and said we weren't going to announce asteroids on the basis of observations on a single night," says Marsden. As a result, a wealth of single sightings are lying unsorted in his database, like so many odd socks.

What if that repository were mined for information about Earth-threatening asteroids? Could a computer sift through all the odd socks reported by professionals and amateurs, looking for matches?

"That's a very important question to ask," says Lucy McFadden, an asteroid expert who worked with A'Hearn to set up the SL-9 exploder at Maryland. She's not sure the answer would be yes, though. Finding small, dim asteroids is no job for backyard telescopes. There's an art to it, and only a few instruments in the world are up to the job. A lot of the reports in the archive are therefore likely to be junk.

Even though many amateurs are skilled observers, the truth, says Marsden, is that "when some amateur reports something and we haven't heard of him before, chances are it's not going to be anything."

Then again...

John Stull, like Jack Brooks, waits for a call that could come any night, telling him that a gamma ray burst just went off in his part of the sky. A semi-retired physics professor at Alfred University in New York, Stull is another member of the Santa Barbara Astronomy Group, now branched out to different parts of the country but all linked to the BACODINE network.

Stull knows that his chances of being the one to finally crack the mystery, to find an optical counterpart for a gamma ray burst, are slim. But, he says, not finding something is as important as finding something. When it comes to GRB counterparts, "the joy is not the joy of discovery, but the joy of helping constrain the theories." Besides, he says, "It's kind of fun to be carrying a very small spear in the back row of this opera." If the call comes, he'll be running.

Munich Airport's Thirty Years' War

by Lester A. Reingold

Until recently, the leading sightseeing attraction in Germany was Neuschwanstein, a 19th century castle of the extravagant "Mad King" Ludwig II. No longer. That ornate confection of turrets and towers, the inspiration for Sleeping Beauty's Castle at Disneyland, has been overtaken in recorded attendance by a low mound of grass-covered earth.

All day long the tourists come, in good weather and bad, busloads and carfuls from throughout Central Europe—more than a million and a half in one year—to climb the steps to the top of that hill. They've come to gaze at one thing: the new Munich airport. The observation hill, made of dirt moved during the airport's construction, is known officially as the *Besucherpark*, or Visitors Park. But some pilots and airport workers, baffled and amused by the crowds at the summit, refer to it as "the Monkey Hill."

Stand at the park on a day without fog or rain and the visitor appeal becomes a bit more understandable. The sight is a compelling one. Twin parallel runways extend more than 13,000 feet along either side of you. Just ahead is the control tower, the design emblem of the airport. There are five working levels at the top, all sheathed in glass. The tower rises 256 feet over a single terminal one full kilometer—more than half a mile—long. For airplane spotters, the traffic is plentiful—last year, 200,000 takeoffs and landings carrying 13.5 million passengers—and diverse: from Boeing 747-400s bound for Tokyo and Kuala Lumpur to Fokker 50s returning from Cologne and Toulouse. The insignia appearing in greatest abundance, naturally, is the blue and gold flying crane of Lufthansa, which accounts for more than half the traffic at the airport, but more than 100 other carriers operate there as well.

What is probably most startling, though, is the setting. The structure gleams stark, angular, and modern out of the boggy fields of a region of Bavaria known as the Erdinger Moos. Since it opened three years ago, Munich Airport has come to be called "the white airport in the green land."

The Erdinger Moos was a reluctant host to aviation. Munich's new international gateway was erected amid the wetlands and farms only after a struggle that was—in duration, if not brutality—like a second Thirty Years' War. Planning for Munich Airport began back in 1954. The region's existing airport at Riem was close to the Munich city center, a convenience for travelers, but it had no room to grow. In addition, the proximity began to raise safety concerns, particularly after a Convair 340 lost an engine on takeoff in 1960, clipped a church spire, and smashed into a streetcar, killing 52.

The search for a replacement site lasted a quarter-century. Even the winning Erding-North site drew 26,332 formal complaints and 5,724 lawsuits. Construction began in 1980, but it ground to a halt just six months later under court order. The judges ruled that the intended airport would take too big a bite out of the Erdinger Moos. Planners were forced to slash the design, from four runways to two and from 20.5 square kilometers to 15. Construction resumed in 1985, and as the new airport opened in 1992—38 years after the project began—the old one at Riem closed. By that time, the airport's cost had climbed above $5 billion, several times greater than the earliest estimates.

Glacial movement on airport development is hardly peculiar to Germany, of course. The struggle over Munich Airport reflects many conflicts found worldwide: the prerogatives of aviation versus those of the environment, development versus preservation, private rights versus public necessity. But in the opinion of some of those associated with Munich Airport, much of the long saga does result from some distinctively German elements. First, they cite a penchant for detail and legal procedure. Second, they say the national character now includes a great deference to minority rights, in reaction to what Werner Toepel, director of the Bavarian Ministry of Transport, called "the bad experience we had with the Third Reich." A third factor was described by Willi Hermsen, president and CEO of the Munich airport au-

Throngs of tourists climb Munich Airport's Besucherpark *to gaze across the sprawling new facility. The product of a contentious confrontation between airport supporters and environmentalists, the airport boasts some trailblazing features for protecting the environment.*

The battle was uniquely German. In the end, did anybody really win?

ALL COLOR PHOTOS COURTESY FLUGHAFEN MUNCHEN GMBH

thority, Flughafen München GmbH, or FMG. "Germans always have the extreme side, they never take the middle line," he says. "At the moment we're very, extremely democratic. Democratic in a way that if one person is against something, everything is stopped." There are stories of unfinished autobahns held up in court for decades, including some bridges built before World War II that still have no roadway connecting them.

But in the case of Munich Airport, the German political process has frustrated both advocates and opponents. What the officials call democracy, even an excess of democracy, the protesters call hypocrisy. Since the airport, though delayed and modified, eventually was built, those who defined victory as nothing less than an Erdinger Moos free of aircraft feel that they lost. A bitter environmental activist, Martina Rödl, remarked, "Is it democratic? No. It's like theater. They listen to you and then do what they want."

The gulf between the two sides is illustrated in two very different graphic depictions of the same man: Franz Josef Strauss, now deceased, a Bavarian minister-president and leading proponent of the new airport. When Munich Airport opened, a reporter for the *Financial Times* of London said the concourse had "all the charm of the inside of a washing machine." But since then, the stark decor has been transformed with whimsical statuary, shimmering light sculpture, and numerous other displays of modern art. Among the decorative touches is a monument to Strauss, a stainless steel monolith with his profile etched at the top, suggesting nobility and strength. Its inscription pays tribute to Strauss' efforts on behalf of the airport. Near the center of Munich, the offices of the Bavarian Society for the Protection of Nature and Environment also have a rendering of Strauss, but it is far less flattering. In the full-color caricature gracing the back of one door, grotesque jowls surround a malevolent grin. *That*, the environmentalists seem to say, is what we think of the man and his airport.

At Munich, aircraft are de-iced on concrete pads equipped with a drainage system, enabling the fluid to be captured and recycled (above). Eight-inch-thick concrete walls in a sound-insulated hangar shield airport neighbors from the noise of engine tests.

Environmentalism is taken very seriously in Germany. For example, the per capita rate of waste recycling is more than twice that of the United States. Germany's Green Party began as an environmental advocate and, though it now promotes other campaign themes as well, protection of the environment is still its chief concern. Other parties are larger, but the Greens wield substantial power, as theirs are often the pivotal votes in parliamentary coalitions.

Munich Airport was built over environmentalists' objections, but its presence does not simply signify the triumph of concrete over nature. Bavarian activists may wince at the claim that Munich has "the world's first green airport," but their advocacy did have an impact. The airport reflects unprecedented environmental progress in both construction and operation. During construction, more than $500 million, about 10 percent of the project total, was spent on environmental protection. FMG may not always have been successful and its efforts may not always have been

voluntary, but the airport authority says it has tried to strike a balance between what Willi Hermsen called "economy and ecology." At the airport's opening, Hermsen said, "For the former, [the airport] is the guarantee and prerequisite for a flourishing future; for the latter it is an ecological sin. I am convinced that neither of these extreme views is correct. It is, rather, a model of how economic demands can be combined with ecological consideration."

Munich Airport officials point out that 70 percent of the complex remains green terrain. Landscaping for the project included the planting of over a million bushes and about 5,000 large trees, at a cost of more than $100 million. But Claus Obermeier of the Bavarian Society for the Protection of Nature and Environment is not impressed; he says that's like destroying Yellowstone Park to make way for an airport and then camouflaging the loss with a little greenery. Those substitute trees and bushes, he says, "don't change the fact that a landscape was destroyed that was here for thousands of years."

Comparing the Erdinger Moos to Yellowstone seems a bit of an overstatement. The land may be ancient but it's hardly pristine. Human intervention is apparent in the network of canals that crisscross the region and date back to 1824. Moors have been drained over the years, and farms now take up much of the territory.

To compensate for losses to wildlife habitats from airport construction, FMG developed a total of 2.3 square kilometers offsite as new homes for birds and other animals. But Christian Magerl, a biologist and leader of the Greens in Bavaria, counters that the sites are too little, too late, and in the wrong places.

Another concern of the environmentalists is the effect the airport has on bird migration. Particularly when they're molting, waterfowl such as the White Stork and the Gray Heron like to shuttle between two lakes in the Erdinger Moos looking for food. The airport now sits in their path. That discourages birds from migrating and endangers those that try, Martina Rödl says. But Egon Renz, head of FMG's environmental department, asserts, "The birds seem to know how to avoid the aircraft."

Which side is right? Has the airport made itself a good neighbor, or has its presence hastened the demise of animal populations? Answers are elusive; it's hard for the naturalists to prove an animal population loss is linked to the airport, and it's hard for the airport defenders to prove the same loss would have occurred without it.

Another argument about cause and effect centers on water. A high water table makes the Erdinger Moos a wetland. To keep aircraft from skidding on frost, dikes and wells were built to lower the water table within airport grounds. This drew anguished objections, particularly from farmers. Many recalled that when a large canal lowered groundwater sharply in 1919, devastating droughts and floods followed. Wind erosion ruined fields, and clouds of dust, hundreds of feet high, blocked the sun for days. FMG said nothing like that would happen. According to Helmut Hofstetter, who heads the water control program, preliminary studies have shown "no great changes. Perhaps there are little changes, some areas where the meadows aren't as green as before."

A number of farmers, though, say the changes have been anything but slight. Each one sounding like a Bavarian Job, they point to dying trees, brown grass, diminished milk production, and foundation cracks in farm buildings that have shifted along with the ground. So far, the airport has paid no compensation, and Hofstetter will commit only to studying the damage. As with the wildlife losses, the question is which changes were caused by the airport and which would have occurred without it.

An FMG video concedes that "every airport puts some stress on the environment." But measures have been undertaken at Munich to minimize that stress. Planners there had the advantage of a fresh start. It's much easier to

Scattered around the airport grounds, cabbage plants growing in canisters help airport officials assess air quality (left), while more traditional equipment documents airport noise in surrounding communities (above). Over 60 percent of the trash at Munich Airport is recycled (right); the goal is 70 percent.

From the air, the airport's impact on the landscape is dramatic; its impact on the ecosystem is still being debated. One plentiful species is the flying crane of Lufthansa (right). The German airline accounts for more than half of the airport's traffic.

include environmental design elements from the beginning, rather than adding them in later to an existing structure. For example, at Munich, aircraft are de-iced on concrete pads equipped with their own drainage system. As meltwater and de-icing fluid are shed from the aircraft, they flow through channels into large tanks and are then trucked to a recycling station. Rather than entering the community water system, the glycol-based de-icing fluid is processed for reuse.

At times, runways and taxiways must be de-iced as well, and that fluid cannot be recycled. To protect local groundwater, Munich's runways have concrete channels along both sides, which direct the runoff to a reservoir and then on to a water treatment plant. At taxiway edges, plastic sheeting, sand, and gravel trap the runoff below ground, where soil bacteria break down the glycol into water and carbon dioxide.

Munich Airport has two air quality monitoring stations, which keep continuous records of pollutants such as sulfur dioxide and carbon monoxide. In addition, scattered amid the concrete, aircraft, and ground vehicles, there is the incongruous sight of cabbage plants growing in canisters. These too are measuring devices for air quality. The waxy surface of the broad crinkled leaves collects hydrocarbons from jet exhaust and motor vehicles. The leaves will also become discolored if they've been exposed to significant quantities of ozone. A chemical analysis of the plant's tissues can provide more specific information about pollutant levels.

For a glimpse of the less glamorous side of aviation, visit Munich Airport's recycling plant. Here the flotsam and jetsam of the jet age are processed for reuse: huge glittering mountains of metal foil that once covered hot in-flight meals; vats of glass; plastic containers crushed and baled into cubes, ready for transport to firms that will melt them down. Food waste from the airport restaurants is shipped to a nearby pig farm. Grass clippings go to a compost company. Currently, 62 out of every 100 pounds of waste at the airport are recycled. The goal is a recycling rate of 70 percent. In the United States, municipalities are said to be doing well if they reach 20 percent.

The airport has also adopted a variety of measures to limit noise. Engine tests are conducted in a sound-insulated hangar with eight-inch-thick reinforced-concrete walls. And Munich, like several other airports in Europe, discourages noisy aircraft by imposing financial penalties on them. For example, an airline pays about $1,800 each time it lands a new Airbus A320, while an old Boeing 707 could incur a landing fee of some $6,000.

Nonetheless, such measures are not enough to satisfy some nearby residents. Confrontations arise whenever homes are near flight paths, but the situation at the Erdinger Moos was the type that can be most contentious. As FMG's Egon Renz put it, these people were "acoustic virgins." On one day aircraft noise was unknown in their communities; the next day they had about


Lufthansa
Lufthansa
Lufthansa
Lufthansa

Protest dogged much of the airport's 38-year struggle toward completion. One of the most prominent voices was that of biologist and Green Party activist Christian Magerl (center). "Songbirds not thunderbirds," the banner reads in part.

550 flights to contend with.

As many on the industry side see it, angry public reaction is often a matter of expectation overruling perception. They say nearby residents see the aircraft, know their reputation for noise, and complain, without differentiating between newer, quieter aircraft such as the Airbus A320 and older, increasingly scarce aircraft like the Boeing 727. Thus, the complaint rates are higher on sunny days when the aircraft are plainly visible, than on cloudy days, when the aircraft are hidden. "If they don't see them, they don't hear them," one air traffic controller commented. Munich officials recall that on the airport's opening day, the first noise complaint came in at 5:00 a.m.—before any aircraft had taken off.

Out of respect for residents' sleep, the airport is limited to 38 late-night flights, but there are complaints that the airport uses loopholes to exceed the limit. Residents recall that when Munich hosted a European Cup Finals soccer match in 1993, the jets roared all night. Airport officials say it's true the limit can be exceeded with special permission, and charter flights for that match were a particularly urgent example. Mindful of soccer fans' reputation for rioting, the Bavarian government was eager to send them back to their homes as fast as possible.

To help preserve some measure of quiet in communities near the airport, FMG is paying for noise insulation in residents' homes. By the program's end, bedrooms and living rooms in about 4,000 homes will receive sound-deadening windows, as well as ventilating systems that pull in fresh air when the windows are closed. The cost will total nearly $100 million.

Munich was not the first airport to go to such lengths. Japan may have done the most, with more than 165,000 homes around 16 airports insulated so far and more to follow. Amsterdam insulated all the homes in a community near Schipol Airport, but in return obtained a commitment that no new housing would be built in the area. That's the sort of *quid pro quo* urged by the Airports Council International: noise aid for people already living nearby in return for measures to prevent still more development.

When land and funds are available, an airport's surest defense is to surround itself with a buffer of undeveloped property. Says ACI environmental affairs chief Avi Gil, "The best advice I can give an airport in the middle of nowhere is to buy a hell of a lot of land and keep it." Munich did that. The airport itself takes up 15 square kilometers but it acquired 44.

The biggest controversies are largely resolved at Munich, but they're cropping up elsewhere. Cities such as Chicago are trying to choose between building a new airport and upgrading an existing one. Such struggles are lengthy, sometimes intractable, because of the conflicting messages a population gives its air transport industry. People may say "not in my back yard" to airports, but they still want the mobility and worldwide access that air travel provides. It's human nature to avoid hard choices, to want to have it both ways.

But the choices, eventually, are forced

Since the airport's opening three years ago, most of the controversy about the $5.3 billion facility has subsided.

upon us. The imperatives are in the numbers. There were 15.6 million commercial aircraft departures in 1993, the latest year for which figures are available, and that traffic has been forecast to double in 15 years. The worldwide commercial jet fleet will double as well, to some 24,000 aircraft. Quite simply, those aircraft need places to land.

Fortunately, commercial aircraft, though increasing in numbers, are also becoming quieter and cleaner. And imaginative ground-based solutions are turning up. Osaka's new Kansai International Airport, for one, is built on a man-made island in Osaka Bay. Primarily in Europe and North America, airports are preserving the habitats of endangered species, often under government mandate. Munich's is now one of many airport authorities to target noise and pollution.

Such initiatives won't end all environmental conflict involving airports. But they may avert an impasse and help keep all parties working together, however uneasily. Ultimately, they may at least help preserve both the ecosystem and the air transport system.

Most of the tourists who come to watch aircraft at Munich Airport's Visitors Park don't know that there are two other observation points as well, one near the north end of the airport perimeter and one to the south. Like the hill frequented by the tour buses, these hills are terraced and flat on top, like Mayan pyramids. The outlying hills are farther from the runways and aprons than the central one, but closer to streams, fields, and the wildlife habitats developed by the airport management.

On a cool day in autumn, the only people standing at the top of one of these hills were a group of naturalists led by Christian Magerl. As he pointed out the environmental changes wrought by the airport, a Turkish Airbus climbed into the sky. At the same time, a flock of birds took off, flying furiously in the opposite direction. And for that moment, the whole contentious development of Munich Airport was reflected in a single tableau: On one hill, a crowd of bird fanciers. In the distance, facing them on the opposite hill, a crowd of airplane fanciers. And situated uncomfortably in between, the Erdinger Moos and its airport.

COMMENTARY:

In the Name of Science

Of the 88 constellations recognized by astronomers today, about half were already defined and named by 400 B.C. Historians of astronomy now believe that the 12 zodiacal constellations are much older, originating in the earliest Sumero-Akkadian cultures of Mesopotamia and first expressed as early as 6000 B.C., even before the invention of written language, with symbols representing concepts still understood today. It is a tribute to the genius of these early astronomers that the names and characteristics they recorded endured over the millennia.

For years I have wondered what inspired these symbols, and my curiosity led me to examine their earliest records—cuneiform tablets, cylinder seals, boundary stones, cult statuettes, and other artifacts of Sumerian, Akkadian, and Babylonian culture. I wondered if the zodiacal signs were keys to the values and beliefs of these early civilizations. And it was while I was studying these ancient records that I happened to see a relevant article in a modern record, the Russian newspaper *Izvestia*.

ALAN E. COBER

On June 26, 1992, a headline read: "Why has a person whose name was adopted for a celestial planet been arrested?" The accompanying article referred to asteroid number 4267, named ANVLAD after Anatoly Vladimirov of St. Petersburg. The discoverer of the asteroid had bestowed this name to show his gratitude to Vladimirov, who had donated generous sums to the Institute for Theoretical Astronomy of the Russian Academy of Sciences, especially to support the study of minor planets. According to *Izvestia*, however, Vladimirov was not only a patron of science but a brutal racketeer. His company, which he called "A Planet," was, the newspaper reported, a front for organized crime.

I did not follow Vladimirov's case and don't know whether he was convicted of these crimes, but it occurred to me then that it was certainly possible for an asteroid to be named after a convicted felon. After all, by agreement of the members of the International Astronomical Union, the discoverer of an asteroid has the right to name his discovery whatever he chooses. The only constraint is that names with political connections have a waiting period: The namesake must have been dead for 100 years.

The contrast between today's practice of naming minor planetary bodies and the ancient tradition I was studying is depressing. Our predecessors filled the sky with imperishable images that convey universal themes: the duality of human experience expressed in Gemini, for example—good and evil, male and female. But today celestial objects can be, in effect, bought and sold, a sad fact that exemplifies a degradation of mankind's spirituality.

It is true that only minor bodies like asteroids are likely to be named after criminals. The IAU guidelines that govern the naming of all other objects ban the use of names of the living and of people who have died within the last three years. Presumably illegal activities or other ethical lapses will come to light in that time. For political or military figures, the ban extends the 100 years required for minor bodies to 200 years for planetary features. Names must also be submitted to various working groups for review, but this review is mainly a device for avoiding repetition. These minor guidelines are simply not adequate to continue the brilliant tradition that our ancient predecessors began.

The IAU guidelines have at least served to ensure that most names reflect international, as opposed to merely national, heroes and values. A review of their origins, however, will demonstrate that the regulations could have done more.

They were developed in 1961, largely as a result of the rivalry between the Soviet Union and the United States in lunar exploration. At that time most of the features on the near side of the moon had been observed and mapped, but no one had ever seen the far side of the moon. In 1959, at the height of the cold war confrontation, the first modest photographs of the far side of the moon were transmitted by the Soviet spacecraft Luna-3. Suddenly there were many new lunar features to be named.

To Nikita Khruschev Luna-3 had great propaganda potential. When it came time to name the features that the probe had discovered, the Soviet Union proposed some blatantly political names, such as Sea of Moscow for one of the large maria and the Soviet Mountains for what appeared to be a significant mountain chain.

A. A. Gurshtein urges astronomers to give their discoveries names worthy of their profession.

These proposals divided the IAU into two camps. One side, which included representatives from Holland and France, considered it the traditional right of the discoverer to name new objects. But Gerard Kuiper of the United States responded that choosing names to further a political agenda set a dangerous precedent and said the naming process should be an international act.

After stormy debates, a compromise was reached. During the 11th General Assembly of the IAU at Berkeley, California, in 1961, 18 new Soviet names were announced, including Mare Moscoviense and Montes Sovietici. Simultaneously the group adopted an agreement for the regulation of naming lunar formations discovered in the future, which introduced the restrictions mentioned previously as well as the procedure of submitting names to committees for approval.

Four years later, the IAU had occasion to invoke the regulations. U.S. and Soviet missions had continued to map the moon, and both countries submitted names to the IAU, which integrated all proposals into a single list. It was my good fortune to participate in the selection of names, and I remember several of the debates that took place. For example, Academician Valentin P. Glushko, who was the Soviet space program's chief designer, proposed naming chains of craters after the Soviet design bureaus that were pioneering cosmonautics at the time. Donald Menzel, then director of the Harvard College Observatory and head of the IAU lunar commission, objected. He pointed out that Soviet bureaus were state-owned but U.S. ones were private. The Boeing Company, he added, would be happy to have its name on the moon and would even pay for the advertising, but that was hardly a fair way to represent all the nations of Earth.

In spite of some outrageous political antagonism, our committee developed a proper collective approach to the problem. At the 14th General Assembly of the IAU in Great Britain in 1970, 513 new names for features on the moon were approved. The map of the moon became a pantheon honoring the scientists, science fiction writers, philosophers, and other prominent persons from different epochs and different lands. For the first time the lunar surface featured the names of people from Australia, India, Canada, Mexico, Rumania, Finland, and Japan.

Our ancestors filled the sky with symbols that convey universal themes.

There was also a special agreement to waive the ban on using names of the living. Six craters were named for U.S. astronauts James Lovell, William Anders, Frank Borman of Apollo 8 and Neil Armstrong, Buzz Aldrin, and Michael Collins of Apollo 11, and six for Russian cosmonauts Gherman Titov, Konstantin Feoktistov, Alexei Leonov, Andrian Nikolaev, Vladimir Shatalov, and Valentina Tereshkova (the first woman in space).

Had we been less focused on petty political quarrels and more attentive to the spirit that was guiding this great age of exploration, we astronomers might have bequeathed better procedures for the next wave of discovery. The Working Group for Planetary System Nomenclature, established by the IAU in 1973, oversees only what discoverers must not do. It provides no guidance or inspiration for what they might achieve.

As spacecraft surveyed the solar system in the 1970s, finding new moons and new features on the planets, astronomers designated their astounding discoveries with only mixed success. The naming of surface features on Mars is to a certain degree an extension of the lunar namings. Martian features for the most part bear the names of great scientists. However, since Viking 1 landed on Mars during the U.S. Bicentennial, some craters near the landing point were named for the cities that were prominent during the struggle for American independence. Other craters were named for the harbors of countries that had traded with American states, a monument to free market negotiations.

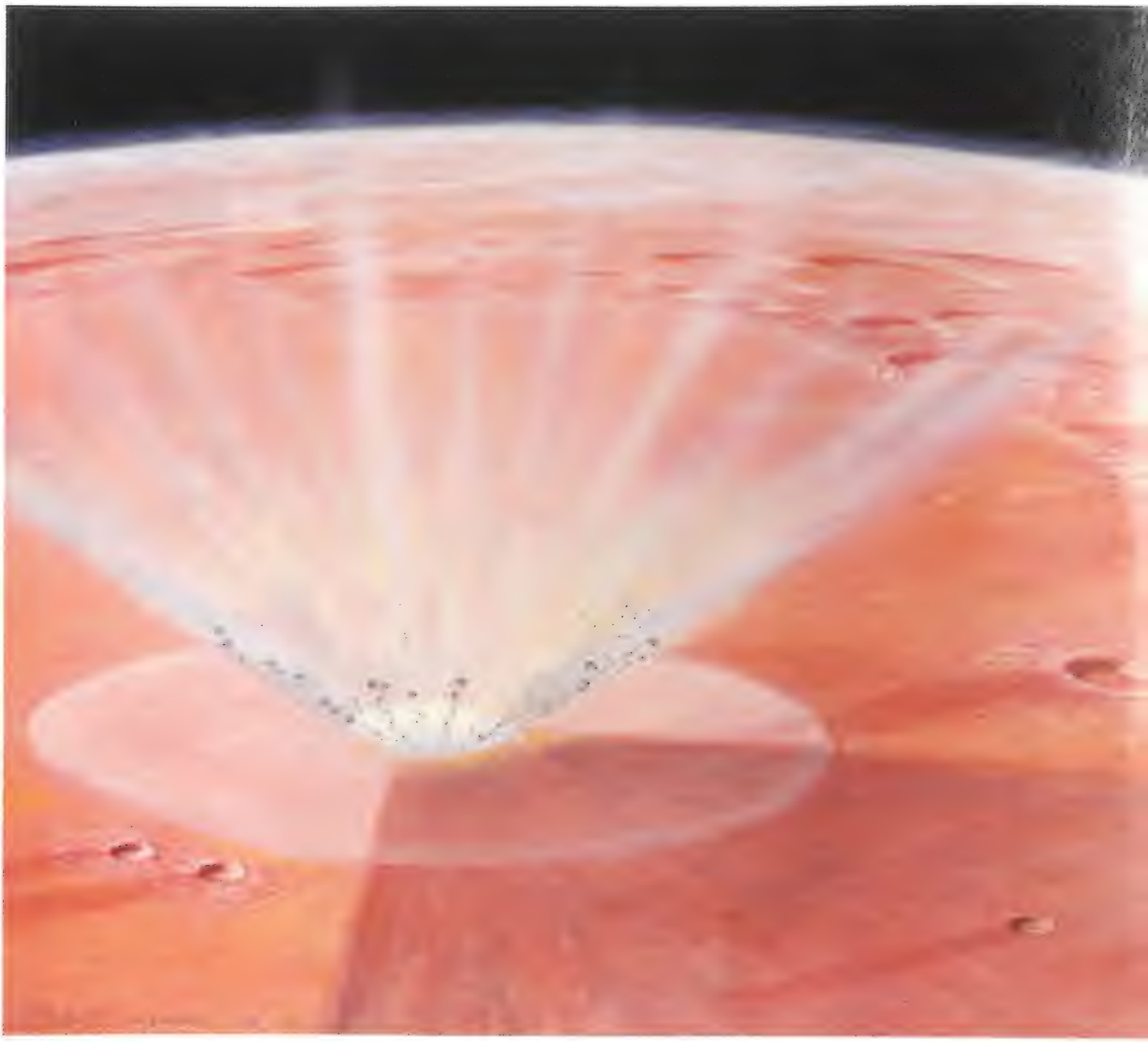
In a political effort to redress the injustices done to women over the centuries, astronomers set the planet Venus aside as a female preserve; only women's names—real and legendary, ancient to current—were used for relief features on the surface of this planet. Mercury became a reservation for the people of culture and art; no scientists or statesmen allowed.

These compartmentalizations don't adequately reflect the human qualities that drive us to explore the solar system. Many millennia ago our ancestors lacked broad theoretical knowledge, but working instinctively, they built a tradition that reached into the essence of humanity. Today we have no adequate guidelines, conceptions, or procedures to achieve results of the same significance. Our imagination is too poor, our approaches too eclectic. Of course, criminals don't appear in the sky every day. But we astronomers have not created an eternal monument for the historic era we are witnessing. We must continue to seek words and names to express the spirit of the Space Age.

The author is an astronomer and historian at the Institute for History of Science and Technology, Russian Academy of Sciences in Moscow.

The Mars Mission to

Who says we have to go to Mars to get Martian rocks to study? Pieces of Mars have been traveling to us.



Earth

by Billy Goodman

WILLIAM K. HARTMANN

A large asteroid impact blasts material off Mars. In a circuitous journey taking millions of years, some of these rocks may find their way to Earth—and into a scientist's hands.

In 1815, nine pounds of Mars landed in France. In 1911, another piece of that planet hit Earth's atmosphere, exploded, and fell in Egypt in 40 pieces, one of which killed a dog. Other pieces have fallen in India, Brazil, and Nigeria. Four more have been found in recent years in Antarctica, including the latest discovery, which was collected in 1984 but only recognized as Martian in 1993. In all, 10 Martian meteorites have been identified on Earth.

Of course, none of these meteorites arrived with a return address, and when a handful of pioneering geologists first proposed Mars as their source, few in the scientific community agreed with them.

"Ridicule would be kind" is how Harry McSween remembers it. During his brief foray into Yankee territory as a graduate student at Harvard in the late 1970s, McSween—now head of the geology department at the University of Tennessee—was one of the few scientists who proposed that the category of meteorites known as SNCs originated on Mars.

The name SNC—pronounced "snic" by some and "S-N-C" by others—comes from the common names of three of the meteorites, each of which represents a different rock type. Shergotty was an 1865 Indian fall; Nakhla, the 1911 canine-killer; and Chassigny, the 1815 French fall. The SNCs are igneous rocks—they crystallized from magma—and they are dated by how long ago they solidified. Chassigny and the three nakhlites crystallized 1.3 billion years ago. The five shergottites present a far messier picture, as their radioactive clocks were started by different events, such as the original crystallization or the clock-resetting event that ejected them from Mars. Most geochemists who have studied them think they are no older than 1.3 billion years. They may be only 180 million years old. These ages are remarkably young, given that other igneous meteorites apparently crystallized some 4.5 billion years ago, shortly after the formation of the solar system. (While the most recently discovered Martian meteorite has much in common with the other SNCs, it represents a different rock type and appears to be much older.)

The relatively recent crystallization of the SNCs told geologists that the rocks' parent body was still hot billions of years after it formed—hot enough, in fact, to melt rock. That seemed to rule out smaller planetesimals, such as asteroids, which cooled off quickly. Only a body as large as a planet ought to retain heat that long.

Nonetheless, at the time the Mars-origin hypothesis was being proposed, experts on impacts and cratering dynamics thought that it would be impossible to launch a meteorite from the planet without it completely melting or even vaporizing. Because no known meteorite had ever come from the moon, these skeptics argued that no meteorite could ever arrive intact from Mars, where the velocity needed to escape its gravity is twice as great. Thus, the discovery of a lunar meteorite would be a key development in the Martian meteorite story. In a fortuitous case of scientific timing, that discovery was not long in coming.

If a meteorite from the moon was going to be found, chances are it would be found in the Antarctic. In the past 20 years, the number of meteorites recovered there has doubled the world's stocks (see "Meteorite Hunting in Antarctica," p. 44). Antarctic expeditions from the United States and Japan collect hundreds of meteorites yearly.

As the 1981-82 field season wound to a close, glaciologist Ian Whillans of Ohio State University visited the U.S. camp. On January 18, 1982, Whillans and John Schutt, the mountaineer re-

WILLIAM K. HARTMANN

The amount of cosmic rays they absorbed suggests that some Martian meteorites may have begun their voyage shielded inside larger chunks. A collision with an asteroid (above) later exposed them to space.

sponsible for guiding U.S. scientists across the ice fields, ventured 20 miles out of camp on snowmobiles. A low cloud deck and poor surface definition made conditions bad for travel but excellent for spotting meteorites on the ice. "Under cloudy conditions meteorites really stick out," says Schutt. "Fist-sized meteorites can be seen hundreds of meters away."

Whillans, who had never found a meteorite before, quickly spotted one about the size of a golf ball. Schutt recalls being excited about it because it was so different from other meteorites he'd seen. Most meteorites have a black fusion crust, created when the meteorite's outer surface melts during passage through Earth's atmosphere; this one had a gray-green fusion crust. The meteorite was designated ALHA81005 because it was the fifth meteorite found during the 1981-82 field season in the Allan Hills.

A few months later a small piece of ALHA81005 made its way to the utilitarian office of Brian Mason at the Smithsonian's National Museum of Natural History in Washington, D.C. Mason took a slice of the meteorite thinner than a piece of paper, put it under a microscope, and almost immediately zeroed in on an astonishing birthplace: the moon.

Having examined rocks brought back by Apollo 16, Mason recognized in this thin section fragments of a mineral called plagioclase, which is abundant on the moon. Furthermore, the meteorite was a breccia—made of fragments of plagioclase in a brown, glassy matrix—a sure sign that it formed from the pulverized debris left by previous lunar impacts.

A few months later, 18 groups of scientists who studied the meteorite addressed the annual Lunar and Planetary Science Conference. One by one, scientists rose to proclaim that the meteorite did indeed come from the moon, prompting one meteoriticist to marvel that 18 labs could agree on anything.

Shortly after ALHA81005 was pronounced lunar, more direct evidence materialized that the SNCs had come from Mars. Geochemist Donald Bogard at NASA's Johnson Space Center in Texas was trying to determine the age of a glassy bubble in a shergottite. Bogard was unable to arrive at a straightforward age, he says, apparently because large amounts of gases were trapped in the bubble. When he analyzed those gases, the results didn't look like what he'd found in other meteorites he'd studied. "We were struck," he says, "by the fact that there was a lot of similarity between what we measured in the meteorite and what Viking measured on Mars" (two Viking missions landed on Mars in 1976).

Bogard is widely regarded by colleagues as a cautious experimentalist, not given to jumping to conclusions. When preparing a lecture about the meteorite, he wrote down the arguments for its being Martian, having to convince himself before he was ready to present the jolting news to peers. He didn't want to find himself in the position he'd seen colleagues in—identifying some interesting component of a meteorite as extraterrestrial only to find that the results were a product of Earthly contamination.

Bogard's results inspired Robert Pepin of the University of Minnesota to measure isotopes of nitrogen in the gas. The Martian atmosphere, as measured by the Viking probes, has a unique nitrogen isotopic signature. Pepin's results supported Bogard's: The shergottite EETA79001 had trapped some of the atmosphere of its parent body, and that atmosphere was unmistakably Martian.

Today, there is little dispute that the SNCs are Martian. Some scientists advocate abandoning the term SNC altogether and just referring to "Martian" meteorites. The Smithsonian's Mason agrees that the SNCs come from Mars,

RICHARD NOWITZ

Hundreds of meteorites a year pass across Brian Mason's table for preliminary analysis.

but when he examines one for the first time, he never calls it Martian. He calls it by its name—shergottite, nakhlite, chassignite—just as he would call, say, a coarsely crystalline terrestrial rock made largely of quartz and feldspar "granite." "In my book," he says, "meteorites are rocks. Extraterrestrial rocks should be classified the same way as terrestrial rocks—by chemistry and mineralogy."

In collections around the world, there are now 10 meteorites from the moon and 10 from Mars. While the lunar meteorites expand upon the knowledge gained by the 842 pounds of rocks and soil that the Apollo astronauts brought back from the moon, the Martian samples inform virtually all research about Mars. Scientists studying the atmosphere, mantle, crust, or past water content of Mars all look to the meteorites for clues. Not all the clues are straightforward.

For example, geologists would dearly love to know how much water is stored beneath the Martian surface. Water speaks of the possibility of life, and even though most geologists have given up on life still existing on Mars, the possibility of fossilized life-forms continues to tantalize. The amount of water on Mars remains a popular subject of debate, with some geologists pointing to valleys and other surface features as evidence of underground torrents of water and geochemists concluding that, based on the isotopes in the Martian atmosphere, there is much less water.

Some have looked to the SNC meteorites to answer the question. McSween and Ralph Harvey at the University of Tennessee used the presence in some SNCs of a water-containing mineral, amphibole, to arrive at an estimate between the extremes. Now, says McSween, further study suggests their estimate marks an upper limit on the amount of water on the planet, which ought to please the crowd advocating a drier Mars.

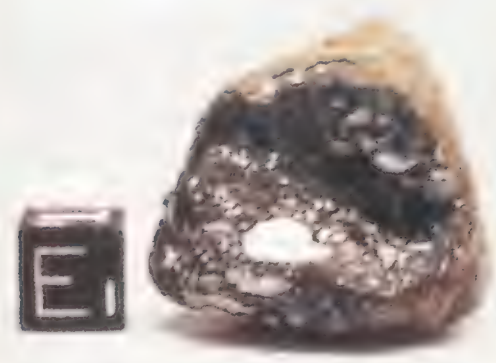
"I had high hopes these meteorites would help us solve the question of how wet or dry Mars is," he says. "But it's a lot tougher question than we thought." Lacking a clear-cut answer to an important question, McSween doesn't despair. "I don't get jaded about the prospect of holding a piece of Mars in my hand," he says.

Harvey, the young meteoriticist who leads U.S. meteorite-hunting expeditions in Antarctica, devotes much of his laboratory work—now at Case Western Reserve University in Cleveland, Ohio—to Martian meteorites. The fact, he says, that "they have been processed in the internal heat of a planet gives us a way to study them. They are similar to Earth rocks that have gone through similar processes, so we can study them like we study Earth rocks." For example, meteoriticists use minerals and trace elements to compare meteorites to one another and to draw inferences about the parent magmas of the SNCs.

If geologists could pinpoint where on Mars the SNCs came from, our knowledge of Mars would skyrocket. Are they

NASA/JSC (2)

DESIGNATION: ALH84001
ORIGIN: Mars
AGE: possibly 4.5 billion years



DESIGNATION: ALHA81005
ORIGIN: Moon
AGE: 3.9 billion years

Scientists studying meteorites from Mars (including the most recently identified, left) owe a debt to the first meteorite known to have come from the moon (right), which showed that rocks could indeed travel from one planetary body to another. In the images above, centimeter-wide cubes indicate scale; numbers following the standard designation identify the section of the meteorite shown.

Meteorite Hunting in Antarctica

Meteorites don't fall more often in Antarctica than elsewhere, but for a variety of reasons—some obvious, some not—they are easiest to find there.

A rock in the middle of an ice sheet is simple to spot. In the absence of a nearby mountain or glacial moraine, the rock is likely to be a meteorite. To improve their chances of finding extraterrestrial rocks, however, meteorite hunters do not search randomly. They seek out places where the glacial ice is blue and meteorites are transported as if by conveyor belt. In these places, known as meteorite stranding surfaces, the flow of glacial ice runs into an obstacle, such as a mountain range, and slows down considerably. The ice may then sublimate—evaporate—or be worn away by the abrasive power of ice crystals blowing in the ever-present Antarctic wind. Meteorites that have landed on the glacier are then revealed.

A Japanese team first discovered meteorite concentrations in Antarctica in 1969, and research expeditions from Japan have been collecting ever since. U.S. expeditions have been mounted since the mid-1970s, under the direction of William Cassidy of the University of Pittsburgh and, recently, Ralph Harvey of Case Western Reserve University.

Each year U.S. teams of six to eight people are deposited by ski-equipped C-130 transport planes in a promising ice field. The "runways" are completely unprepared, says Cassidy. "The pilots fly over the area once and if it looks smooth, they do a ski drag—still flying but dragging their skis on the snow. Then they go up again and look at their tracks. If they look like dotted lines [evidence of crevasses] they go elsewhere. Otherwise they land. The pilots refer to it as a controlled crash landing."

Once safely on the ground, the meteorite hunters set up camp, consisting mainly of 12-foot-tall pyramidal teepees called Scott tents, after Antarctic explorer Robert F. Scott. Each tent has two camp stoves for cooking and heating. For about six weeks the meteorite hunters will live two to a tent.

On a typical day they rise about 7:00 a.m., make radio contact with McMurdo Station, the main U.S. research outpost, to say that all is well, have a hot breakfast, and then set out on orange and black National Science Foundation-issued snowmobiles. They are led by mountaineer John Schutt, who scouts out safe passage through the crevasses, which can be wide enough to swallow the snow machines. "We'll go kilometers out of our way to avoid large crevasses," says Harvey.

Since the expeditions are mounted during the Antarctic summer (our winter months), the weather is not especially harsh, with temperatures typically hovering around 0 degrees Fahrenheit. However, Harvey says, "We're looking for areas where the ice is swept free of snow, so that means lots of wind—usually 10- to 20-knot winds, which brings wind chill way down. If winds blow more than 20 knots, we don't work." That might happen one day in five, Harvey says.

The payoff is worth it. During the 1994-95 expedition, the U.S. team collected 611 meteorites. Harvey admits the ice has other attractions. Apologizing to his telephone interviewer, he says, "The phone doesn't ring. And it's a very pristine environment. I like the raw nature of it, a terrain that has remained untouched by human hands. The mountains look rugged, the sky is often blue. It's quiet; there's nothing to hear except the wind."

RANDY KOROTEV

Ski-equipped C-130s carry U.S. meteorite hunters to and from Antarctic ice fields.

RALPH HARVEY

The typical expedition campsite features a few comforts of home—plus wind, cold, and lots of ice.

the result of 10 separate impacts, or just one? How deep were they buried when dislodged? The 10 rocks arrived on Earth without a shred of contextual evidence, but with some key clues for geologists trying to identify the site or sites on Mars that spawned them.

Allan Treiman, one of the players in the find-the-crater game, would, like most geologists, rather spend his time in the field collecting rocks. "It's frustrating to have samples and not know where they are from," he says. "I lose the tools that geologists have. We can't look at field relations [of the SNCs]—which lava flows sit on which other ones—or trace them back to a lava source. Sometimes lava flows have lots of variation. But we have no idea whether the rocks we have are typical of a lava flow or are something very special."

When we spoke, Treiman, of Houston's Lunar and Planetary Institute, was on his way to Canada to examine ter-

DAVID NANCE (2)

Trapped gases in one meteorite gave Donald Bogard the first clue that the rock had originated on Mars.

restrial flows in which rocks similar to nakhlites have been found. He's hoping that by gaining an understanding of the Canadian rocks, he and his colleagues may be able to speculate about how the Martian ones formed. Meanwhile, he and others have been trying to tease enough clues from the Martian meteorites to identify the crater or craters on Mars from which they were ejected.

All agree that the 10 SNCs were not launched by 10 separate impacts. Several lines of evidence make that highly improbable. The most convincing, according to many meteoriticists, is the length of time the meteorites spent in space, which is estimated based on cosmic ray exposure.

Cosmic rays are fast-moving atomic particles produced by the sun and other stars. When they hit rock, they penetrate to varying depths before hitting interior atoms and causing a cascade of nuclear reactions. Rutgers University geochemist Greg Herzog likens these reactions to a break in billiards. By examining the products of the reactions, which remain in the rock, scientists estimate how long the rock was exposed to cosmic rays. To be exposed, a rock must be at the surface of a planet or hurtling through space without much other rock shielding it. What's more, the cosmic ray signature of a rock on the surface of a planet will be different from the cosmic ray signature of the same rock in space. On a planet's surface, the rock is exposed on one side only ("2-pi exposure"), while in space the rock is exposed from all directions ("4-pi exposure").

Scientists who have studied these matters, including Herzog, say that because the Martian meteorites show no 2-pi exposure, they must have been at least several meters deep when launched. The ages of their 4-pi exposure form three—possibly four—groups. Chassigny and the nakhlites were exposed for about 13 million years, four of the shergottites were exposed for 2.5 million years, and one shergottite was exposed for less than one million years. Analysis of the most recently identified Martian meteorite, ALH84001, places its exposure duration at about 16 million years, but further interpretation of the data is needed.

The obvious explanation of these ages is that four separate impacts on Mars launched the meteorites, 16 million, 13 million, 2.5 million, and 0.7 million years ago. But the obvious explanation is not necessarily right. Treiman and others argue for just three launches: the shergottites together about 2.5 million years ago, Chassigny and the nakhlites about 13 million years ago, and ALH84001 about 15 million years ago. The shergottite with the anomalously young exposure age, Treiman suggests, was shielded by other rocks until a collision in space 700,000 years ago exposed it to cosmic rays.

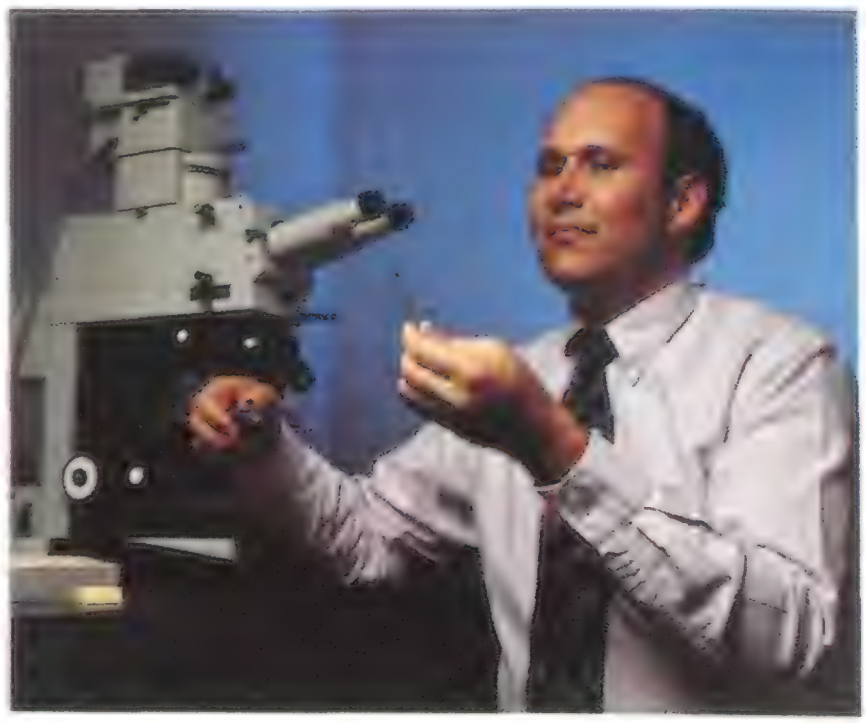
For some scientists, even three launches is too many. A leader of the one-impact camp is Jay Melosh, who studies cratering dynamics at the University of Arizona. Known for his early opposition to the SNCs-as-Martian hypothesis, Melosh changed his mind and developed the leading hypothesis for how large impacts eject material intact from planets.

Melosh doesn't find his turnaround on the origin issue as remarkable as it sounds. Early on, the acceptance of Mars as the parent body of the SNCs was becoming something of a bandwagon, he believes, and he proposed reasonable alternatives. The evidence from trapped gases in one of the SNCs convinced Melosh of their Martian origin, and he began studying how Martian rocks could be ejected.

Melosh thinks that the SNCs were all thrown from Mars some 180 million years ago when an enormous impact formed a crater as large as 125 miles in diameter. The rocks we would come to know as SNCs were shielded from cosmic rays for most of their journey in space inside several truck-size blocks of Martian crust. Extraterrestrial collisions shattered those blocks, exposing the SNCs to cosmic radiation for their final few million years in space.

Melosh and colleague Ann Vickery have searched for the crater where they believe the SNCs were born. Not only must the crater be huge, it must be on

Allan Treiman, holding a chip from one Martian meteorite, hopes to identify the sites on the Red Planet that yielded the rare rocks.



BRUCE ZAKE

Ralph Harvey, pictured with a group of extraterrestrial acquaintances, divides his time between labwork in Cleveland and meteorite-hunting missions in Antarctica.

relatively young volcanic terrain, since the nine conclusively dated SNCs are all 1.3 billion years old or younger. Though the Arizona geologists haven't found such a crater, they are undaunted. "Any scenario we've been able to think of has some disagreement with the facts," says Melosh. "Until we get more samples, we really won't know what is going on."

One puzzle meteoriticists must explain is why these nine SNCs seem to come from young volcanic terrain, which covers, according to most estimates, only about five percent of the Martian surface. Melosh argues that it is indeed unlikely that all the SNCs would come from a rare terrain—unless they are all the products of a single impact event.

Perhaps, some geologists suggest, the older parts of Mars have been so weathered and beaten that their rocks have become very fragile and do not remain intact when thrown up by a large impact. Or, Treiman says, the cratering rate might be higher than thought, meaning that areas of Mars that appeared very old might actually be much younger than believed. If so, more of the Martian surface could be young enough to have spawned the SNCs, bolstering the argument for multiple impacts.

The most recently discovered Martian meteorite may help settle some of these issues. The four-pound rock was found masquerading as a more common type of meteorite in the Antarctic collection at Johnson Space Center. In 1993, Dave Mittlefehldt, a scientist with the Lockheed Engineering and Sciences Company, was measuring the composition of minor minerals in the rock and noticed some minerals and unusual grains of carbonate that hinted at Martian origins. Further testing has verified that.

Some of the ways this rock differs from the other Martian meteorites have geologists excited. While clearly similar to the SNCs, for example, the meteorite is composed almost entirely of the mineral orthopyroxene, a different kind of rock. And the grains of carbonates it contains—minerals that were probably deposited when liquid coursed through the rock on Mars—indicate that Mars may have once had a more Earth-like atmosphere. Preliminary evidence also suggests that the meteorite is much older than the other nine. Depending on how much older, the age might point to an origin in the Martian highlands, separate from the other SNCs—or might even jeopardize the notion that the meteorite came from Mars at all.

Chips of the rock have gone to researchers around the world. Two labs, in Germany and at the Johnson Space Center, are trying to determine when the meteorite crystallized. Their preliminary results are exciting: The meteorite seems likely to be 4.5 billion years old, meaning that it crystallized about the time Mars formed. If the age is confirmed—and if researchers continue to believe it came from Mars—then the sample may help scientists rethink the chronology of Martian cratering, the mechanics of getting meteorites off the planet, and the early geological evolution of the planet.

RICH MAYS

Even when scientific answers are elusive, Harry McSween says he doesn't "get jaded about the prospect of holding a piece of Mars in my hand."

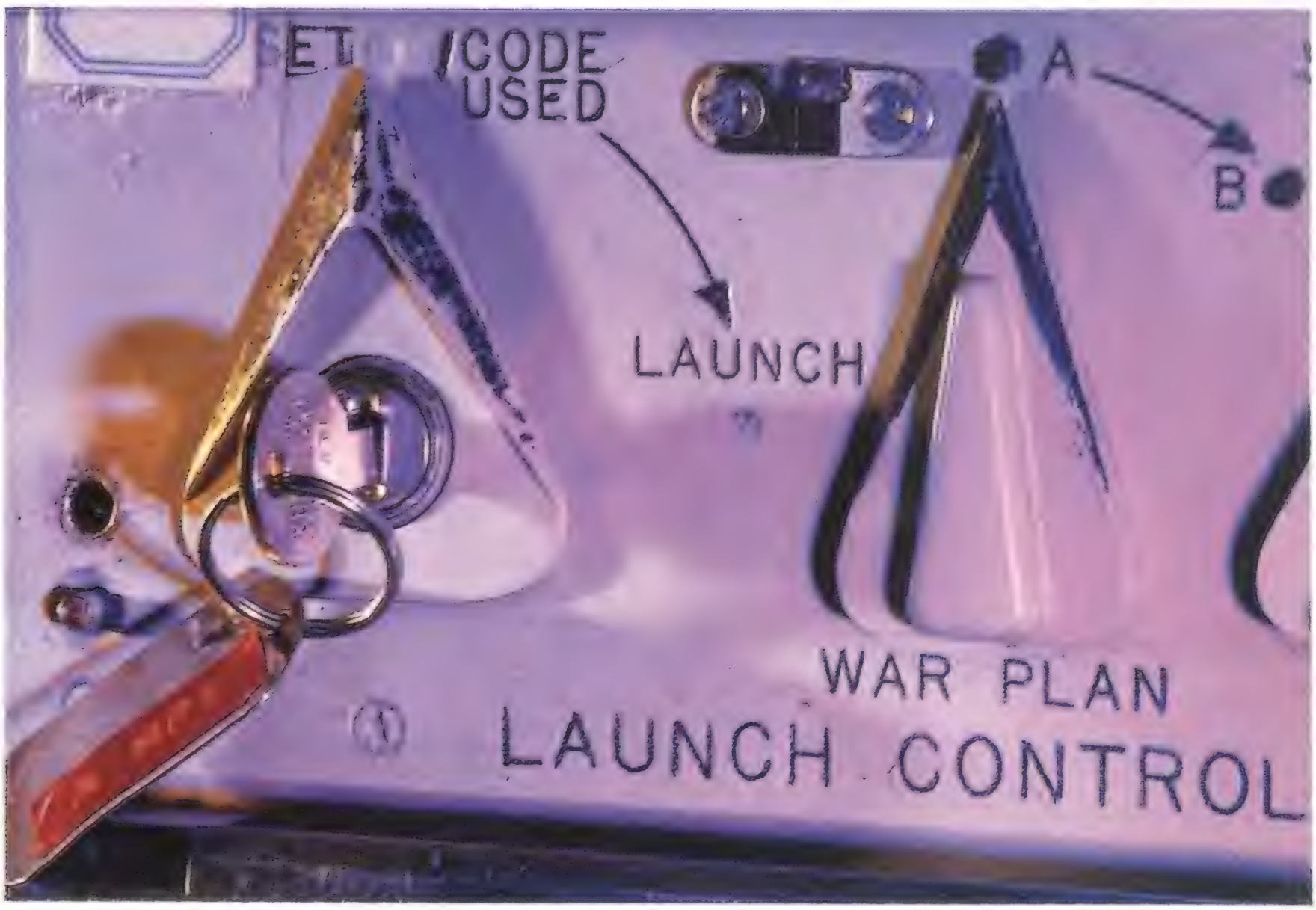
There's only one way to find out if a Minuteman missile works. Here's how they do it.

THIS IS ONLY A TEST...

With the turn of a key at an underground launch facility, a Minuteman III begins a 4,800-mile test ride over the Pacific.

by Matthew Jaffe

Photographs by Chad Slattery



The July dawn arrives at California's Vandenberg Air Force Base as little more than a rumor. A thick layer of ocean fog cloaks the sprawling base in gray silence. Red-tailed hawks perch drowsily on roadside electrical lines, and even the base's ubiquitous gophers are slow to stir from their burrows.

It is a deceptive quiet. In buildings around the base, Air Force and civilian workers are busy preparing for the seven o'clock launch of a Minuteman III missile. Inside a former Titan missile bunker built into a stabilized dune, a room buzzes with banter and business as technicians monitor the Minuteman and its various systems. A few miles away sits the launch control center, which is filled with industrial green, 1960s-vintage computer equipment. There, missile combat crew members First Lieutenant Walter Jimenez, 24, and Captain Wilmer Jackson, 30, prepare for the high point of their young careers. Soon they will launch a real missile.

The launch is only a test, part of Air Force Space Command's Follow-On Operational Test and Evaluation program.

Even as cold war tensions ease, strategic weapons planners need to know how well the nation's aging land-based missiles will perform. Designed for a life of 10 years, Minuteman missiles have stood on alert for more than 30, thanks to upgrades of their solid fuel and guidance systems. Further modernizations could extend the system's role as a nuclear warhorse until 2020.

Montana's bleak landscape is home to dozens of missile silos, which are frequently located on farmland hundreds of miles away from their base. The remote sites mean long days for the security teams who escort the warheads (stored in the trailer above) while they're in transit.

Practice runs like today's (which is one of only three Minuteman test launches the Air Force conducts per year) help ensure that the missiles and their crews will be prepared in case of a real war. And, if necessary, both Jackson and Jimenez say they wouldn't hesitate to turn the keys that launch the missiles. They've turned those keys hundreds of times during training sessions. Today it's a bit more real.

Jackson and Jimenez have come to Vandenberg from Malmstrom Air Force Base in Montana, where they monitor the readiness of 10 nuclear missiles hidden among the plains and foothills surrounding the base. Part of the 341st Missile Wing, they are required to pull 24-hour shifts inside capsules buried up to 100 feet beneath the ground (see "Life in the Egg," Oct./Nov. 1994), where they run through lengthy checks of each missile's systems and troubleshoot emergencies, which can range from guidance system failures to security sensors set off when animals wan-

der across the ground above the silo. Crews often describe the job as "23 hours of boredom and one hour of sheer terror." Or as Jackson says, "I'm a babysitter of missiles. One of them cries, I take care of it."

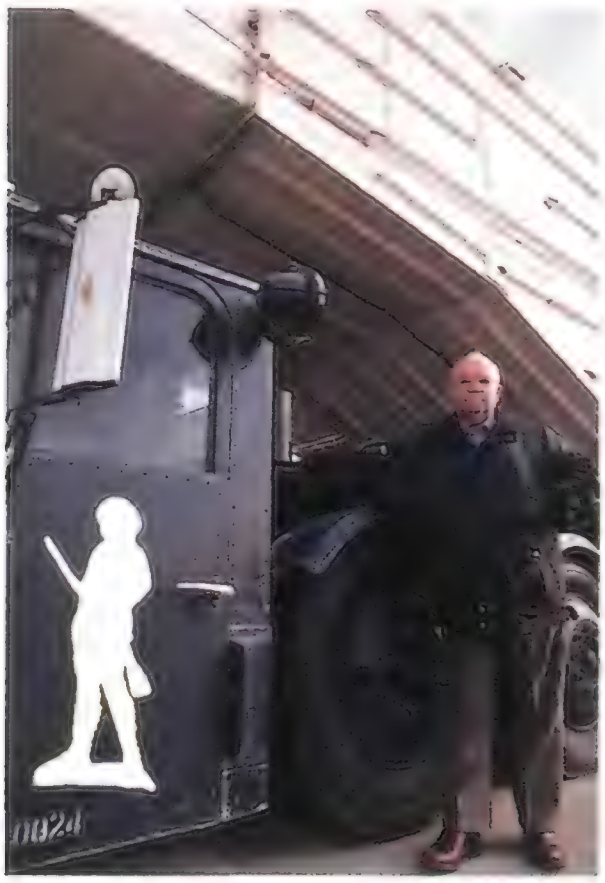
Unlike the whitewashed beauties on display at Vandenberg's entrance, the Minuteman III that Jackson and Jimenez will launch is a 60-foot-tall, 75,000-pound, primer-green monster. The three-stage missile has become a no-nonsense Frankenstein of a weapon, patched with spares, upgraded parts, and cannibalized sections of other missiles. In the same way that an operational B-52 has essentially been rebuilt over the years, the typical Minuteman III is an accumulation of upgrades. The Air Force has replaced parts in the guidance system, while the third stage has an improved motor.

Unlike earlier generations of missiles, such as the liquid-fueled Titan and Atlas, the Minuteman III uses a solid propellant that combines fuel and oxidizer in a substance the consistency of creamy peanut butter. The advantage of using solid fuel is that it is much safer and easier to handle than liquid fuel. Over time, however, the solid propellant can separate from the walls of the missile, or sag, preventing a smooth burn. Periodically, manufacturers clean out both the second and third stages and replace the propellant.

After the Minuteman III has been randomly selected from a list of missiles on alert (the number of the chosen missile is literally drawn out of a hat), a two-day operation to get it started on its journey be-

A helicopter ferries crews and equipment to the launch site, where removing the missile (viewed from the bottom of the 80-foot silo) is an eight-hour operation.

Missile engineer Dale Enger (below) has worked on the Minuteman program since 1962, when Montana received its first generation of missiles.



For the journey from Montana to California, the Minuteman's three rocket stages ride aboard a C-141 transport.

gins. An Air Force contingent—missile maintenance, M-16-toting security guards, and mere observers—travels along the Missouri River, over low rolling hills, and past weathered ranch houses to descend on the site.

The maintenance crew's job today is not substantially different from their usual routine. When launch control teams like Jimenez and Jackson detect a problem, it is the maintenance teams that must head out to make repairs or bring parts back to base. Lately they have been busier than usual, replacing Minuteman IIs with Minuteman IIIs. And thanks to arms treaties phasing out the 10-warhead MX, or Peacekeeper, missile, the Minuteman III will become the United States' sole land-based intercontinental ballistic missile. In addition to a new motor and propellant, the Minuteman III will receive the more advanced MX guidance systems and carry just one warhead instead of three.

The missile sites that Malmstrom personnel are responsible for cover 23,000 square miles of Montana, and many of the silos are located 100 to 200 miles away from the base. Sometimes helicopters have to ferry equipment and security police to the more remote silos. Other teams drive to a site, making a three-hour trip across big empty country covered by wheat and rangeland. The occasional business like the Byway Cafe, a restaurant that sells homemade sticky buns, offers such a break from the bleak landscape that it takes on an almost legendary stature.

The harshness of the land can make life difficult for the maintenance crews, who sometimes have to remove four feet of snow from a site just to begin work. "If it hits 30 below with wind chill getting to minus 70s, they'll go ahead and cancel," says Senior Airman Michael A. Bentley. "It's not worth sending us out and risking somebody getting frostbite to do this job. It's not a life-and-death thing."

A day earlier, blowing snow and packed ice had forced the maintenance team to turn back and cancel the operation. Today's weather is better. The wind blows hard, but temperatures rise into the 30s. Under an azure sky, the snow shines white on distant purple mountains.

The silo site, designed to be inconspicuous, blends in with acres of farmland. The only thing separating the site from the farmer's fields is a chain-link fence, which outlines a rectangle of bare land surrounding the concrete pad that seals the top of the 80-foot-deep silo.

After the maintenance team and a security escort arrive, a ritual of verifications and security checks—"split handling" in Air Force parlance—commences, designed to prevent an unauthorized person from breaking into the silo. Before the crew can even pass through the gate of the chain-link fence, the maintenance chief must first radio a flight security controller and pass identifying information to him. If the information checks out, the flight security controller contacts the missile combat crew overseeing that particular missile to get permission for the team to enter. After the maintenance team and the security escort pass through the gate into the area around the silo, they must again communicate with both the FSC and

the MCC, using a hand-held gadget called a missile electronic encryption device, which relays an identification number and information that only the maintenance and security chiefs would know. Once their identities have been authenticated, the FSC sends the security chief an encrypted combination to open the A-circuit, a round, 166-pound steel door that seals the silo's top. Likewise, the MCC sends the maintenance chief an encrypted combination for the silo's B-plug, a 14,500-pound stopper-like steel device locked by large pins.

Once the A-circuit and the B-plug have been moved out of the way, crews can begin rolling back the massive steel and concrete launch enclosure door. It inches back, disturbing the nests that field mice have built in the narrow gap underneath it. The mice scurry through the shallow snow, panicking at all the activity and the loss of the 110-ton roof over their heads. (Concerned about rodent-borne viruses, the maintenance technicians take care around the nests, although it's the occasional rattlesnake that they really worry about.)

To provide a sheltered work area, a modified semi-trailer is parked over the open silo, where the conical top of the missile is now visible about 20 feet down. A distinct odor rises; eventually, it will work its way into the workers' clothes. It smells faintly organic, stale and musty, with a noticeable chemical spiciness.

While the work is complex and well-rehearsed, the tools are simple—mostly store-bought sets such as Craftsman and Snap-On. The downsiders, a three-person crew lowered into the silo, detach the missile's titanium-shrouded reentry system, which contains the warheads. Two doughnut-shaped work platforms circle the launch tube nested inside the silo, but because the downsiders need better access to the missile, they operate out of a work cage they have lowered alongside it. Cabinets with computers and environmental control equipment (solid fuels must be kept between 60 and 100 degrees Fahrenheit) surround the work platforms, a marked contrast with the tube's bare walls and occasional clusters of cable.

Hoisted by a winch, the silvery reentry system rises toward the trailer, wavering slightly as it climbs. Bentley and his partner, Senior Airman Dean Phelan, receive the assembly, which contains delicate guidance systems as well as three conical reentry vehicles. Though the warhead contained in each reentry vehicle has more than 17 times the power of the atomic bomb dropped on Hiroshima in 1945, the maintenance teams focus on the physical demands of their work and not on the power of the weaponry they deal with almost daily. "But every now and then you stop and think about it," says Bentley, "that this could put a real big hole somewhere."

A security convoy escorts the reentry system to a tightly controlled facility at Malmstrom. There a munitions team will begin the process of disassembly: First the reentry system's titanium shroud is removed, revealing the three reentry vehicles, which are mounted on a payload. Once the RVs are taken down, their warheads (which house the radioactive material and detonation system) can be removed. Then everything but the warheads is packaged and shipped to Vandenberg by truck for the launch. The warheads themselves remain at Malmstrom, where

they are mated with the components for a new missile and taken back out to a vacant silo. The entire disassembly and packaging process lasts 10 days.

Within the Air Force, the missile world is separate from the aviation world. And within the missile world, the munitions workers pride themselves on their own separateness. Says Staff Sergeant Gary Reddicks: "Some people pound a typewriter. We build bombs. We're physically separated, and the job we do is unlike just about any other in our squadron."

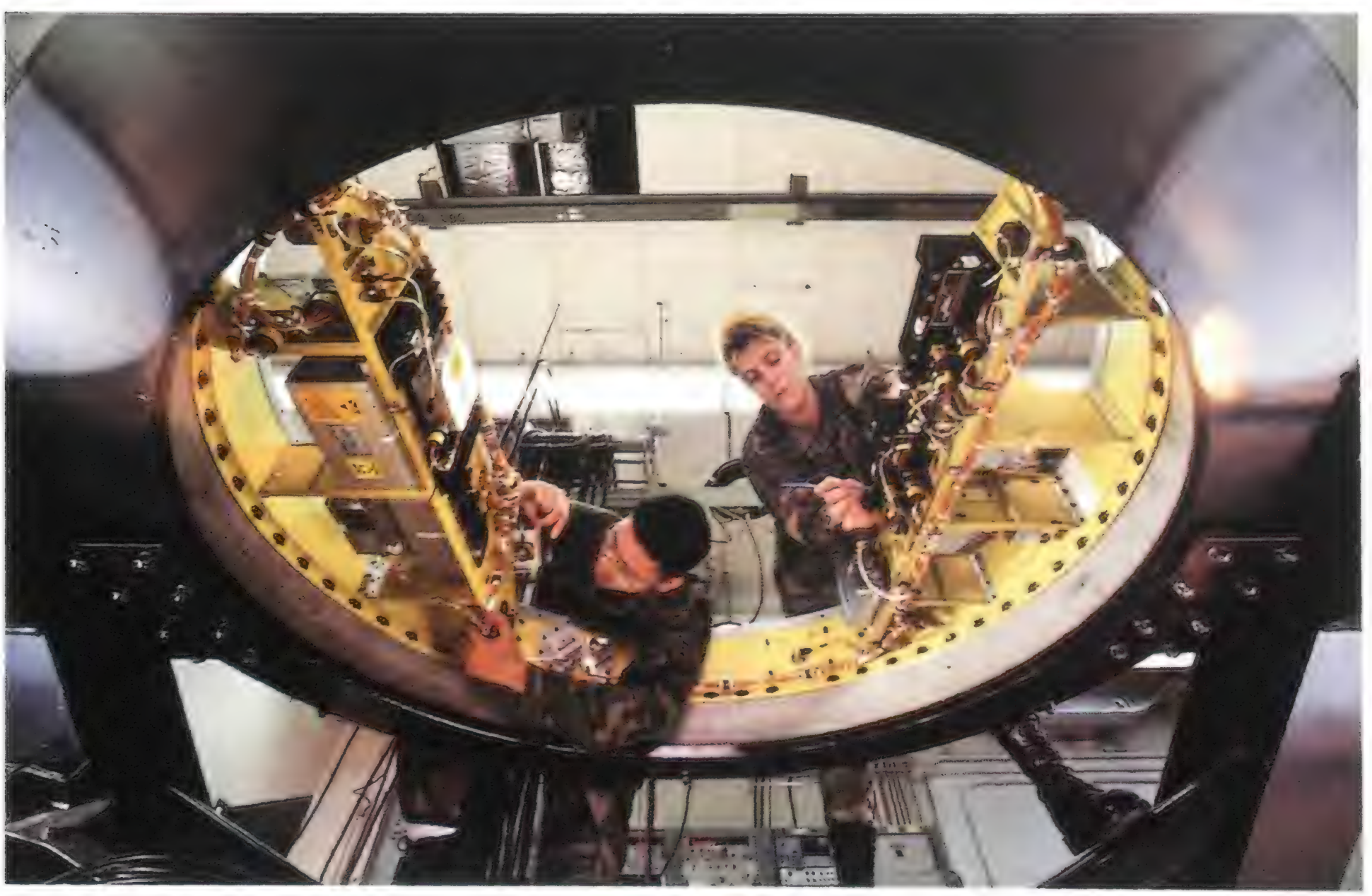
At the munitions facility where Reddicks and crew work, an air of gallows humor prevails. It's not uncommon to hear technicians saying, "If you see me running, get out!" But sometimes—in a building posted with numerous warnings—the alarms are real. One day, as the crew members hone their skills on a set of dummy warheads, word of a gas leak is delivered over the building's intercom. Reddicks and company race out. None of the team have time to grab their coats, and the wind whips through their shirts as base fire vehicles zip into the compound. "Glad it's y'all and not me," Reddicks shouts after them. "That's the job that scares me," he says. "You couldn't pay me enough to do those kind of jobs."

The day after warhead removal, the crew returns to the silo with a transporter-erector—a $3 million, 32-wheel converted truck and trailer—for the eight-hour operation to pull the missile out. The trailer is raised to a vertical position, with one end directly above the silo's opening. An American flag mounted at the raised end snaps in the breeze. A hydraulic system, using miles of heavy cable and a sling rod attached to an adapter ring underneath the missile, slowly eases the weapon into the trailer. Crews closely watch the missile's rise to make sure that it doesn't sway and bang into the launch tube.

After the Minuteman is securely loaded into the transporter-erector, it is lowered back onto the truck and whisked back to Malmstrom. There, technicians load it into a large aluminum container, which is stowed aboard a C-141 transport for the flight to Vandenberg.

Two months later, a 23-person task force arrives at Vandenberg to prepare for the July 6 test launch, which will be directed by Captain Dana Struckman. Before the Malmstrom Minuteman can be launched, however, Vandenberg-based crews must rig it with test equipment. With only three test launches a year, the Air Force needs to gather all the performance data it can, then compare that information to previous test statistics on the Minuteman's fuel system, navigational accuracy, and warhead deployment. So a team installs a telemetry "wafer," a 4.3-

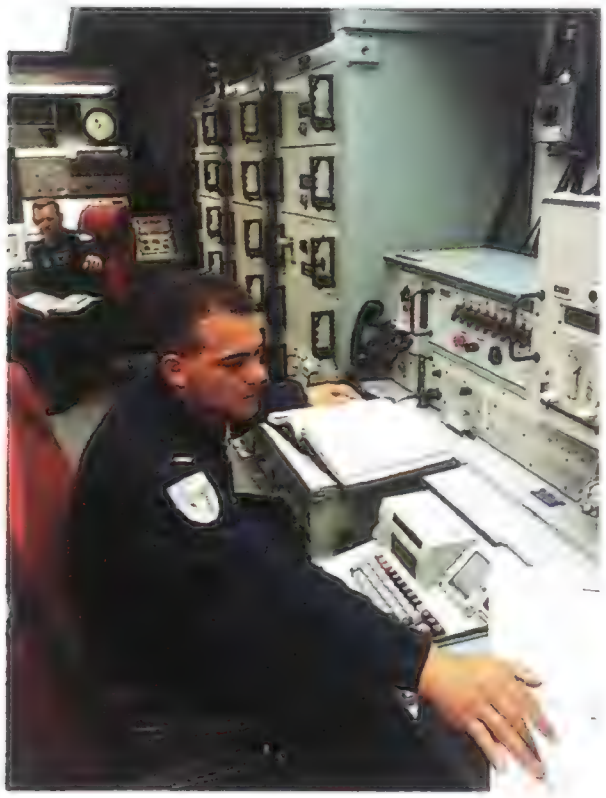
The Minuteman test launch requires weeks of preparation: technicians must reassemble the reentry vehicles, which have been stripped of their warheads (left), and ready a telemetry package that will return information on the missile's flight (below).



foot-diameter metal ring packed with electronics that will transmit information about the Minuteman's performance to receivers along the California coast.

The other major addition is the destruct package. If the Minuteman strays off course, two mission flight control officers, Captain Richard Boltz and Major Jeffery Hetrick, will send a radio signal that detonates explosives lining the missile. The missile's course is displayed on a monitor as a red line. If the missile deviates from the red line, Boltz and Hetrick have to decide its fate within four seconds; if they wait any longer, debris could fall beyond the safety zone. "Like any other operation where you're in a life-and-death situation, time slows down on you," says Hetrick. "It starts to compress."

The two men wear shoulder patches depicting a leering red creature grabbing a rocket, with the slogan "Track 'em or crack 'em." But it's a decision they don't relish. At Vandenberg in June 1993, a Minuteman turned in the wrong direction two seconds after launch, forcing launch control officers to destroy



After years spent on alert in underground launch centers, Walter Jimenez (foreground) and Wil Jackson get their first opportunity to launch a missile. All goes well as the Minuteman bursts out of its silo at 7:14 a.m. and punches through a layer of fog blanketing the California coast.

it. Unfortunately, the fiery debris set off a brushfire that burned 1,000 acres. "As soon as that vehicle comes out of the hole, you don't know whether it's going to go the right way or not," says Boltz. "Ninety-seven percent of the time they do, but it's the three percent that don't that you have to be ready for."

Out in the missile alert facility, which is located a few miles away from the building where Boltz and Hetrick are stationed, Jackson and Jimenez settle in for the countdown. Says Jimenez: "You're going through the same procedures in taking care of the missile, but [during a test] you always have the sense of relief in the back of your head that if something breaks down, it's a big deal, but it's not as life-threatening as if you had a nuclear weapon out there." The facility is like a submarine: long, narrow, and fluorescent. About 20 minutes before launch, Jimenez struggles to change a console panel that was installed too tightly, while Jackson talks to the command post via a black cold war-vintage dial telephone. Three miles north in a seaside silo, the missile awaits the signal to launch.

At 6:55 a.m. the crew receives word from one of Struckman's support staff at the command post that the launch is on hold because of concerns about the strength of the telemetry signal. Holds are routine, but this one comes after the Minuteman's batteries have already been activated. Once turned on, the batteries can't be turned off. If the launch doesn't happen before the batteries lose power, it will have to be delayed three days while maintenance workers replace them. And a longer delay could mean that Jackson and Jimenez might have to return to regular duty, losing their chance to launch.

But having verified that everything is working, Struckman orders the count to resume. At 7:14 Jimenez and Jackson turn and release their keys.

A pretty post-launch phenomenon is the refraction of sunlight through the Minuteman's exhaust contrails (above). The exhaust also creates a messy job for two technicians, who must remove gobs of burnt insulation to get the seaside silo ready for the next launch (right).

The missile's rocket motors fire 30 seconds later. There's a quick burst of orange, then a brighter flash as the Minuteman III rises for a few seconds before being engulfed by a fog bank. Because of the distance, it takes about 15 seconds after the flash for the missile's roar to wash over the site.

Boltz and Hetrick won't be doing any cracking today. The big green monster has punctured the fog bank's ceiling and accelerated through the blue morning sky, pushing toward its peak speed of 15,000 mph. Stage separation goes smoothly, and five minutes after launch, the three disarmed warheads deploy well above the atmosphere (the exact altitude is classified). Then, glowing brightly from the heat of reentry, they continue arcing toward the South Pacific for another 25 minutes before finally splashing down 4,800 miles from Vandenberg.

Later, Jimenez and Jackson stop by the missile alert facility in between preparations for the long drive back to Malmstrom. Even as they accept congratulations for their work, the mission feels somewhat unreal. They're eager to see the launch video. "You're really not thinking it's going," says Jimenez. "You put your hand on the key, like you're trained, and turn it. Then it's like: Okay, what happened?" ✈

STEVE SANDSTROM

Whole Lotta Jumpin' Goin' On

There is no sport in the world like skydiving, and there is no skydiving event like the World Freefall Convention.

by Frank Kuznik

Photographs by Erik Hildebrandt

Jumpers call Quincy skydiving's Disneyland, complete with E-ticket rides like a Super Constellation (above) and a Bell LongRanger (right).

For 355 days a year, Quincy, Illinois, is a placid farming community on the Mississippi with a modest commuter airport carved out of the cornfields east of town. Then, in early August, the airport is transformed. Thousands of skydivers descend on the little facility, turning it into a skydiver's mecca and creating a mushrooming tent city. For the next 10 days, the participants in the World Freefall Convention will take turns leaping out of a veritable candy store of jump aircraft.

At last summer's gathering, the most popular craft was an Amerijet Boeing 727. With a capacity of 185 and an exit speed of 155 mph, the cargo hauler was a magnet for jumpers who wanted to make like D.B. Cooper, the legendary outlaw who got away with $200,000 by parachuting out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the rear door of a Northwest Orient 727 in 1971. It was back for its third year, and the jumpers flocked to it during its day-and-a-half run like kids chasing an ice cream truck, whooping in anticipation as they belted themselves to the cargo bay floor. The accommodations were like steerage: hot, no windows, and jumpers packed in long, tight rows. But on takeoff, a roar of approval erupted, and at altitude the skydivers began an enthusiastic chant of "Jet! Jet! Jet!" as they stood, adjusted their suits and helmets, then dashed out the cargo doorway.

"Awesome!" declared Robert Clupper on the ground afterward, gathering his parachute and beaming. Clupper is no stranger to jets; he flew 747s for United Airlines. Skydiving has been a retirement pursuit. "It makes my heart go pitty-pat," said Clupper, 65. "And that's good."

A big, friendly man who is nearly bald, Clupper wore glasses and a black jumpsuit with rainbow stripes on the sleeves and a large patch on the back showing a bearded geezer parachuting in his rocking chair. Which is to say, he fit right in at the convention, a collection of proud iconoclasts who are part of a growing subculture.

Membership in the United States Parachute Association has ballooned to 28,500, a number that reflects an annual three to five percent growth rate. The World Freefall Convention is the largest skydiving event in the world; in 1994 it attracted more than 2,600 jumpers from 20 countries. Over 10 days, they made 30,972 jumps, setting a new record for number of jumps at any one event. Several new one-day records were set as well, capped by Jet Day, when the total number of jumps was just shy of 4,000.

On the down side, the 1994 convention also recorded one fatality and 21 injuries, mostly broken bones. Ironically, two of the injuries occurred on day seven, when no jumps were made because of a low cloud ceiling. One man shattered his heel leaping from the roof of an RV, and another fell off the back of a golf cart.

Co-organizers Rob Ebbing (above) and Don Kirlin (opposite) have launched the annual World Freefall Convention at Quincy for five years. The 1994 gathering, with novel jump platforms like the 727, drew more than 2,600 skydivers from around the world.

The jumper who died had inadvertently rigged his parachute backwards, then inexplicably tried to ride it in instead of cutting away to his reserve canopy. It was the second death in the convention's five-year history. The first occurred in 1993, when two skydivers collided in midair. Most experienced jumpers consider the risk of such accidents negligible; they are fond of quoting statistics showing that it's more dangerous driving to the airport than it is jumping out of an airplane.

Quincy's reputation as the Disneyland of skydiving derives chiefly from the number and variety of aircraft it offers. Most skydivers rarely get the opportunity to jump out of anything more exotic than a Cessna 206 or a DC-3. Each year the convention runs a primary fleet of two CASA 212s, four beefed-up de Havilland Twin Otters, and a Beechcraft Super King Air, aircraft that can get up and down quickly. Weather permitting, the turbine fleet fires up at 8 a.m. and runs nonstop until dusk, dropping a load of skydivers every four minutes. "Quincy's great because there's so much flat, open land, and it's not a heavily used airport," said

convention co-organizer Rob Ebbing, an advertising director for a chain of Hallmark stores. "We can run a racetrack in the sky."

Then there are the specialty jumps—out of a helicopter, hot-air balloons, biplanes, and, this past year, the Family Channel blimp. The act of jumping varies minimally from aircraft to aircraft, but skydivers are fanatics about getting new jump platforms to list in their logbooks. "There's nowhere else in the world you can jump that," said Andre Pieterse, a South African horticulturalist, nodding toward the 727 as he explained why he spent $5,000 to get to Quincy.

Surpassing even the 727 as a highlight of the '94 convention was a Super Constellation, flown in for day eight by a preservation group from Kansas City, Missouri. With most of its seats removed, the Constellation could carry 90 skydivers per load—and it did

A tent city springs up in the center of the airport, with street names like Boeing Boulevard and D.B. Cooper Avenue (opposite). Taco and sub stands by the landing zone allow jumpers to touch down, grab a bite, and get another lift. Well-organized skydivers can make 10 jumps a day (right).

12 full loads. "I would have paid just to fly in this thing," said Randy Block, a packaging designer from Chicago, as he stood admiring the contours of the airplane. "Jumping out of it was a bonus."

Even for old hands the convention offered new thrills. Skydiving instructor Frank Arenas had made 6,000 jumps, but he was nonetheless dazzled by his jump from a World War II Naval Aircraft Factory N3N biplane. It was like a movie stunt—reaching up out of the open cockpit at 4,000 feet to grab a pair of handles on the upper wing, sliding out as the airplane went into a loop, then dangling in midair a few seconds before letting go.

"When I dropped, I did a backflip, then looked over to see the pilot in a dive matching my fall rate," Arenas said. "He was 50 feet away from me, with fire coming out the [exhaust] manifold. It just blew my mind. I mean, the visuals—there's just no way you would ever see this on the planet Earth."

The landing zone, a grassy field adjacent to the runways, was a constant bustle of activity. Brilliantly colored parachutes dropped from the sky like confetti amid jumpers packing their parachutes or lining up at a trailer to buy jump tickets. Behind the trailer, under the shade of a huge camouflage net, a masseuse kneaded a steady stream of sore jumpers. Just steps away, a uniformed unit of the Missouri Air National Guard manned a mobile air traffic control tower and a medical station with an ambulance at the ready. Everywhere, stacks of speakers kept up a steady rock 'n' roll groove, interrupted only by loading announcements or hearty cheers when the clouds broke.

STEVE SANDSTROM (2)

Jumping out of a CASA 212, Emory Smith demonstrates the art of skyboarding (above), while Gerald McCullar prefers the basic freefall arch (right). A drop from 12,500 feet allows about 60 seconds of freefall.

The jumpers themselves provided the clearest indication of skydiving's evolution from a death-defying stunt to an organized sport pressing for consideration as an Olympic event. For one thing, nearly a quarter of the people waiting to buy jump tickets were women, who, like their male counterparts, represent a broad cross-section of interests and professions—stockbrokers, secretaries, managers, engineers, tradespeople, pilots, flight attendants, accountants, even an occasional doctor or lawyer, paying between $16 and $59 per jump, depending on the aircraft.

"The joke used to be that skydivers were like bikers, only cleaner," said Don Kirlin, a USAir pilot and co-organizer of the convention. "Now it's evolved into more of a yuppie sport."

The old image isn't completely gone. There were plenty of tattoos on display, as well as skull and crossbones insignias, fireworks, and rockin' good times at the party tent every night. If an occasional nude woman on a motorcycle rode through the crowd, well, it was all part of the fun. But the cost of skydiving alone has redefined the sport.

Thirty-five years ago, surplus Army parachutes were available for as little as $50. Today, a complete set of jumping gear runs from $3,000 to $4,000—with good reason. The "square" parachutes—rectangles, actually—in almost exclusive use among sport jumpers have next to nothing in common with their round white predecessors, which were nearly impossible to steer and landed hard. Square—or ram air—parachutes fly like a rigid wing. They are completely maneuverable and capable of landings so soft that many jumpers go up in sandals, or even barefoot.

The old gear was heavy, drab, and relatively undependable. Today's rigs weigh about as much as a college student's backpack, come in colors like neon green and shocking pink, and have safety features that have all but eliminated equipment malfunction.

"When I started, skydiving was populated by 18- to 22-year-old men, and when you got married you symbolically burned your gear," said Bill Booth, a 30-year skydiving veteran and inventor of a two-person parachute. "Then the gear got lighter, the landing got softer, and women started doing it. Now, with modern training methods and comfortable, good-looking, safe gear, people who are 50, 60, 70 years old are regular jumpers."

the landing zone or on the ramp practicing "dirt dives," earthbound rehearsals for formation jumps of six to sixty. It took pioneers of the sport years to figure out how to control their bodies in freefall, to fall faster or slower and maneuver to meet in midair. Now the techniques are so well defined that load organizers—staff members who organize pickup groups into formation teams—were the busiest people at the convention.

"The first 10-man star, which we did in 1967, was considered quite an accomplishment," said Jerry Bird, an acknowledged "sky god" of the sport and member of the original 10-man team. "Nowadays, every group that goes up can do that." The current world record for a formation jump is 200 people.

Jumpers practice formations by "dirt-diving" just before takeoff (above) to ensure that everyone knows his place and to establish a count and a cue for exiting en masse (below). One of the largest formations at last summer's convention was a 68-way (right). The current world record is 200.

JAMIE PAUL

Literally anyone can make a tandem jump, strapped to an experienced jumper wearing a two-person parachute; nearly 400 tandem jumps were made at Quincy last year. Coral Degagne, a paraplegic, did tandem jumps out of five different aircraft at the convention, including the 727. "That was the first tandem ever out of the jet," she declared after landing.

Skydiving has also become a largely communal sport, as evinced by the groups of skydivers at the convention scattered around

Individual jump skills are constantly being refined with innovations like skysurfing, a precarious freefall balancing act performed on a mini-surfboard, and competitive aerial ballet routines that have begun to attract mainstream TV coverage.

The reasons people skydive are harder to analyze. Some are obvious—the accomplishment of mastering a difficult sport, the unmatchable exhilaration of freefall. But individual motivations cover a wide spectrum.

STEVE SANDSTROM

At $59 per jump, the Naval Aircraft Factory N3Ns were the most expensive transports and also some of the busiest, making four flights an hour, 12 hours a day. Left: Tammy Roquemore exits at the top of a loop.

Today's ram-air parachutes are highly maneuverable and enable such gentle landings that some jumpers wear sandals or go barefoot. At Quincy, the ground is simply a brief stopover point—a place to pack your parachute before climbing aboard the next airplane.

"It was challenging at first, requiring a lot of self-discipline," said Jim Schorfheide, a chemical engineer who drove 820 miles from Baton Rouge to the convention. "Now I do it for recreation; it's relaxing." Linda Hardesty, a parts manager at a California car dealership, credited skydiving with renewing her zest for life. "I used to not care whether I lived or died," she said. "Now I want to live for a long time. I've found something I want to do, and I'm part of a big, tight family."

"I think the main reason that people, including myself, skydive is that they're adrenaline junkies," said Kirlin, a 20-year veteran of the sport. "It is just so exciting to fall through the air at 120 miles an hour and be able to do everything Superman can do—slow down, speed up, move forward, do backflips. It's the only time in your life that you can actually fly. It's one of the ultimate thrills."

The convention also gives skydivers the opportunity to indulge another shared passion: flying machines. Old airplanes, new airplanes, balloons, blimps, biplanes—anything that goes up high enough for a jump evokes unabashed, often wild enthusiasm. National Guard senior master sergeant Cindy Caughlan's air traffic controllers handled some 700 takeoffs and landings a day during the convention, but

the jumpers cheered and applauded and mobbed it the instant the propellers stopped. One group got down on their knees and began bowing and chanting, "We're not worthy, we're not worthy."

"I heard all that hollerin' and saw all the people," a slightly bewildered captain Dick McMahon said afterward. "I just thought, *I hope they're friendly.*"

The Constellation team, mostly retired TWA employees who had crewed on Constellations in their heyday, had a souvenir table set up within an hour, and did a brisk business out of a full-blown booth the next day, particularly with a new batch of T-shirts emblazoned "I Jumped the Connie." Meanwhile, the onboard crew hit it off famously with the skydivers.

"Hey, thanks for bringing your airplane," one of the jumpers said on the final load. "This is a once-in-a-lifetime experience."

"Oh, don't worry," a white-haired crewman replied. "We'll be back next year."

And so another group succumbed to the fantasyland atmosphere of Quincy, where all you really need to fit in is a taste for the freedom of the skies. That much became clear one night at the party tent, where the limited jump slots on the Family Channel blimp were being raffled off to six lucky skydivers.

"Here's the rules for jumping out of the blimp," Kirlin announced to a boisterous crowd. There were the usual catcalls and howls of anticipation, followed by a pregnant pause. Then Kirlin broke into a 500-watt grin. "There are no rules!" he yelled. "You just jump out!"

that wasn't her biggest headache. "It's trying to keep skydivers away from the airplanes," she said. "Definitely."

The Constellation was a good example. The cargo carrier had been converted to a Super G, complete with tip tanks on the wings. In 1986 the Save A Connie foundation rescued the airplane from desert storage for about $4,000 (its scrap metal value), then spent two years overhauling it stem to stern before embarking on the airshow circuit in 1989. Normally it sits on static display, supported by donations from airshow audiences; hauling skydivers proved much more profitable. "We usually get $4,000 to $6,000 an appearance," said Richard Nielsen, vice president of Save A Connie. "At Quincy, we earned somewhere around $12,000 to $15,000" in donations.

When it arrived at last year's convention,

A PACIFIC WAR ALBUM:

PHOTOGRAPHS FROM THE COLLECTION OF LOOMIS DEAN WITH TEXT ADAPTED FROM LOOMIS DEAN, JAMES EDMUNDSON, AND ALLEN RANKIN

Near the end of World War II, the Pacific campaign changed from a series of assaults on Japanese-held islands to an extended series of bombardments of the Home Islands and aerial mining of their surrounding waters. The Boeing B-29 Superfortress, a new U.S. bomber with the range to reach Japan from bases in the Marianas, was designated for operations exclusively in the Pacific. The ensuing blockade marked the beginning of the end of the war with Japan.¶

During an eight-month period leading up to Japan's surrender, Captain Loomis Dean, a photographer, and Major Allen Rankin, a professional magazine writer in civilian life, began compiling a documentary book about the bombing campaign. The project was approved by General Carl Spaatz, commander of B-29 operations during the closing months of the war, and it was to have been the official history of the Superfort and the 20th Air Force.¶

But the war ended sooner than anticipated, and the book was never published. The photographs found their way into Air Force archives, and Dean says he was able to recover the original negatives from the Pentagon only recently, "after I proved that they were all shot on my own Rolleiflex and film."¶

The accompanying album of Dean's photographs portrays the machines and the people as they were 50 years ago in a uniquely intimate way.

A single B-29 "mother" escorts a gaggle of P-51s on a mission to Japan. Fighters needed the bombers' radar and celestial navigation for the long flight from bases on Iwo Jima. When they reached the target, the bombers and fighters exchanged roles, with the Mustangs covering the Superforts.

Radar also allowed the B-29s to bomb through bad weather and at night, conditions that allowed the fighter escort to stay home. Gunners and ammunition were left behind on night missions so that more fuel and bombs could be carried.

Once their escort mission was completed, the P-51s could attack surface targets provided they had enough fuel for the long flight home.

Iwo Jima served as an emergency runway for crippled B-29s, and the island was littered with engines and parts for repairing the bombers and returning them to action. This mechanic is working on a section of cowling and preparing to install a replacement engine. The Curtiss-Wright R-3350s were designed for quick changes, requiring connection of only a few lines. A crack crew of four or five could change an engine in two hours.

When a B-29 detoured to Iwo Jima, it was usually because of low fuel, but many required the caress of a wrench at "Rocky's Repair Station," run by Major Charles A. "Rocky" Stone. Here, jackstands on both sides of an inboard engine raise the bomber just enough to allow three crewmen to wrestle a wheel onto the right main landing gear. Because the high-pressure tires could explode, the crew took shelter behind steel screens when inflating them. Iwo took in about 40 bombers on an average night. After one massive daylight raid, the visitor total came to more than 100.

It took a crew of 11 to operate a fully armed B-29, with a 12th, an electronics officer, occasionally joining the party. In the close quarters aboard, "walk-around" parachutes like those on the ground in this picture were easier to handle than the standard chute pack. The crew also used small portable oxygen bottles when moving around. Flying helmets, goggles, Mae Wests (life preservers), and oxygen masks completed the list of the air crew's accessories. The Superfortress started out the war with only two machine guns in the forward upper turret; it finished with four, like this one.

After every mission, the ground crew scrambled to paint a new bomb on the fuselage; *Easy's Aces* had completed 15 missions.

Bombardiers on most bombers doubled as gunners. The B-29's gun turrets were all operated remotely from sights like this one in the nose. The nose gunner was the only one who could see to fire forward and down, and from here, the bombardier-gunner could operate both upper and lower forward turrets. The B-29's electronic system allowed control of individual turrets to be passed from one gunner to another.

With a load of 500-pound general-purpose (high-explosive) bombs aboard, this B-29 was probably going after industrial targets. A crewman fastens arming wire to the bomb shackle to initiate arming when the bomb drops free. Each bomb had fuses in the nose and tail of its casing. A small propeller on the nose would spin in the airstream until it unscrewed itself and fell free, arming the fuse. Just above the crewman's head is the long tunnel that served as the only connection between the Superfort's forward and aft pressurized compartments.

The B-29 had a rocky start under unrelenting political pressure. President Roosevelt had promised relief to China, and General Henry "Hap" Arnold had pledged to deliver operational Superforts and crews for the effort. But the complex airplane was still being refined as it was produced, which led to delays. During its first months in India, the new bomber went operational while the kinks were being worked out of it—a long and worrisome process.

When it was finally ready for the conclusive assault on the Japanese mainland, the B-29 was welcomed to massive bases in the Pacific, like this one on Guam (above). Runways and taxiways, prepared well in advance of the B-29s' arrival, were paved with crushed coral, and crews worked in the open surrounded by platforms, trucks, tools, and tow tugs. On an inspection tour near the end, Arnold (left, with two reporters) felt confident the gamble had paid off.

Allied forces on the island-hopping campaign bypassed the little island of Rota, near Guam, and isolated Japanese troops continued to inhabit it as the 20th Air Force began operations from the captured island bases nearby. Rota became a practice bombing range, and its cratered surface took on a moon-like appearance. With a front-row seat, the Japanese troops on Rota watched raids depart for their homeland. Like the Allied crews on Iwo Jima, the inhabitants of Rota would lie awake for hours under the thunder of the departing bombers. Many raids took four to five hours to pass overhead.

The Superfort was a good floater and, unless severely damaged, would give its crews plenty of time to exit through hatches and windows. One B-29 ditched during operations in India floated so long in the Indian Ocean that it was finally ordered sunk by naval gunfire.

Airborne and surface search-and-rescue teams ensured that most who got out of the airplane would return to fight another day. Specially equipped patrol aircraft could drop powered boats big enough for a whole crew.

Extended-range auxiliary tanks like these gave P-51 Mustangs the capability to reach Japan. The aluminum tanks were mounted at hard points under each wing and dropped when empty. The airplane was fueled through its normal filling points; the auxiliaries did not have to be topped off separately. Scavenged tanks made passable sailboats when equipped with outriggers made from oxygen flasks and a sail fashioned from a mattress cover (left).

The tedium of the Pacific theater touched everyone. Whereas Europe was an ancient and complex civilization under the grinding destruction of war, the Pacific islands offered mostly barren emptiness, sky, coral—and boredom. With no hope of distraction, every individual coped in his own way.

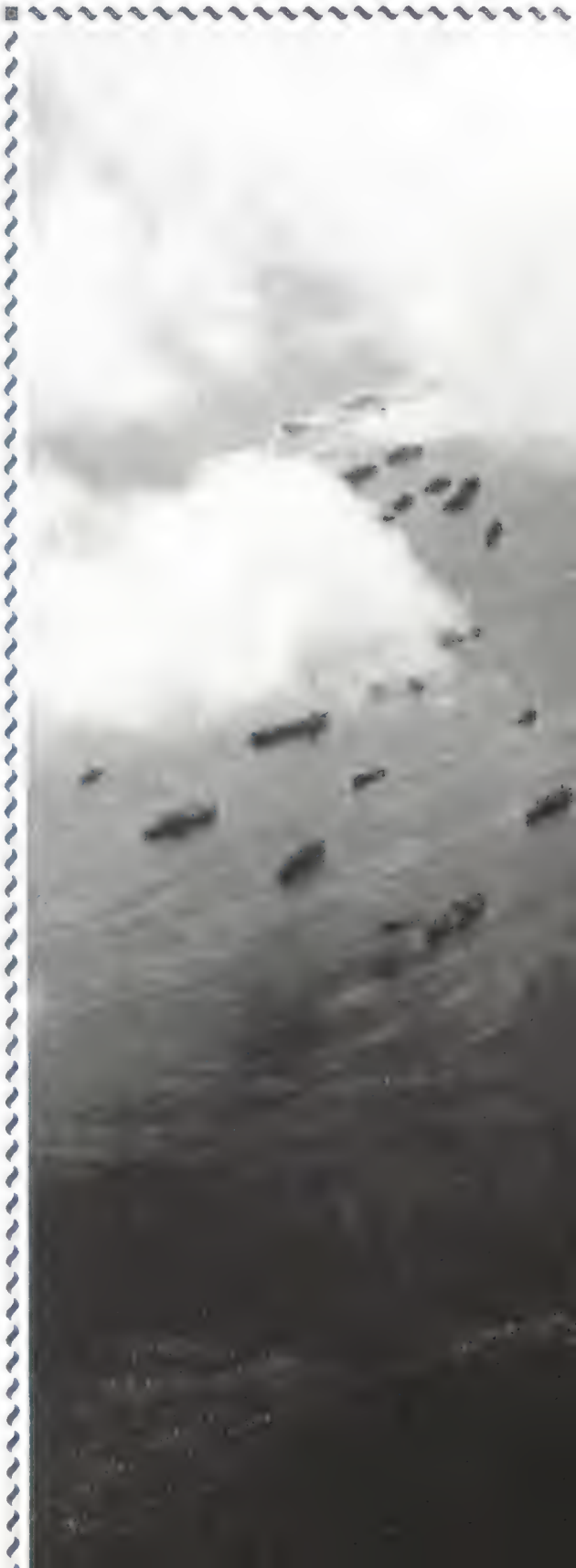
The Curtiss-Wright R-3350 turbo-supercharged engine was one of the most powerful and efficient piston engines ever developed and certainly one of the most sophisticated of the war. Each engine led a spectacular, and usually short, life. The R-3350 tended to overheat, particularly on long climbs to altitude when the airplane was heavy. This scene merely hints at the industrial production that was required for the United States to prevail in World War II.

A gathering of titans: from left, Curtis LeMay (with a pipe in lieu of his trademark cigar), an unidentified officer, Jimmy Doolittle, and Barney Giles confer at an impromptu meeting caught by Loomis Dean's camera. Doolittle was assigned to the Pacific to fashion from his Eighth Air Force a duplicate of the 20th Air Force (the Eighth had completed its job in Europe). LeMay commanded the 20th, and Giles was supporting the effort to set up Doolittle's new headquarters.

If a pilot was unable to feather one of the B-29's propellers after an engine quit, the prop would continue to windmill, but without benefit of sufficient lubrication. When that happened, the propeller shaft heated until eventually the prop fell off. This one departed the number-three engine and appears to have taken some bites out of the fuselage before plummeting into the Pacific.

General Mickey Moore's Seventh Fighter Command on Iwo Jima was an integral unit of the 20th Air Force. As escorts and as a protective fighter cap over the target, Moore's Mustangs played a significant role in establishing air superiority over Japan, a nation that was rapidly losing its ability to defend itself, particularly against such formidable weapons. For the fighter pilots in their confined cockpits, the grueling missions were sheer agony, and it was not unusual for a returning P-51 jock to have to be lifted from the cockpit.

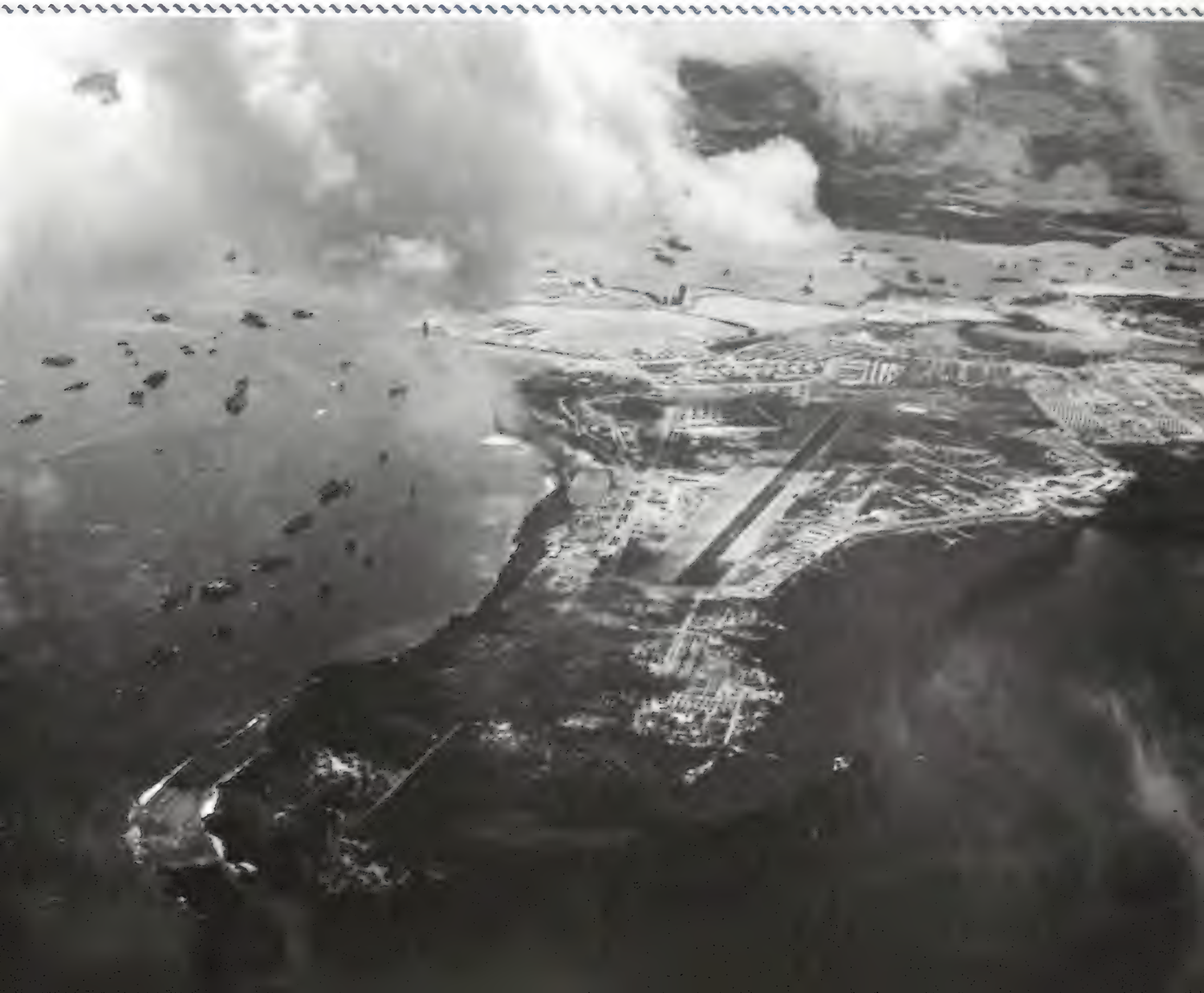
For a raid on Tokyo, the Mustangs drew from auxiliary tanks for the flight north, then dropped the tanks and flew home to Iwo on internal fuel. The approximately 1,600-mile round trip took seven hours and was one of the longest fighter missions in the war. For the bombers operating out of the Marianas, the run to Japan was twice that distance and could take more than 12 hours.



From humble beginnings in Kansas, when they didn't have enough B-29s to conduct training, units that formed the 20th Air Force grew along with the capability of their bombers (left). The Superfortress was the most sophisticated airplane fielded by the Allies, and it brought a rapid close to the Pacific campaign. With five bomber wings operating roughly 1,500 aircraft, the 20th wrote the final chapter in the war by vindicating their airplane and the strategy it was designed for. The armada returned home relatively fresh: On the day Japan surrendered, the *Enola Gay*, which had dropped the atomic bomb on Hiroshima, had flown less than 155 hours. General Roger Ramey (right) led a flight of 500 Superforts over the armistice ceremony.

Toward the end, the tiny island of Iwo Jima could barely contain the equipment and supplies needed to perform its many roles. This unique photograph of the island shows anchored vessels that provided machine shops, gasoline storage, and warehousing, with pipelines and shuttles linking them to units on the beach.

The taking of Iwo Jima had cost more in lives lost per square foot than any other battle. Yet the taking of Iwo eliminated a Japanese fighter base and provided a vital forward airfield for the Allies. For many who fought through the final grueling months of World War II, Iwo Jima was the most powerful symbol of the combination of personal sacrifice and industrial might that characterized America's role in the struggle.



THE LAST RAID

First there was Hiroshima, then Nagasaki, and still no message of surrender from Japan. Before the end, U.S. forces would launch a thousand aircraft on one final mission.

by Daniel Ford

Illustrations by Greg Harlin/ Wood Ronsaville Harlin, Inc.

When word reached the island airfields that a uranium bomb had destroyed Hiroshima, the men in the conventional-bombing squadrons were upset—not by the death of a Japanese city, which after all was the work they did, but by the degree to which the new weapon seemed to diminish the effect of the bombs they carried to "the Empire."

War correspondent Charles J.V. Murphy was visiting Tinian when the *Enola Gay* returned from her 3,000-mile round trip into the atomic age. At a pre-dawn breakfast the next morning—Tuesday, August 7, 1945—he heard Harry Truman's taped announcement blare across the volcanic-and-coral Pacific island, one of three in the Marianas that had been transformed into monster airfields for the Boeing B-29 Superfortress. The United States had harnessed "the basic power of the universe," the president said. (Truman himself was shipboard, returning from the conference in Potsdam, Germany, that had settled the terms Japan must meet.) Surrender, Truman warned the Japanese, or face "a rain of ruin from the air, the like of which has never been seen on this earth."

Murphy walked over to the packed-coral hardstand where a B-29 was taking on conventional explosives destined for Toyokawa, a small city near the Japanese capital. "With a wry smile," as Murphy recalled, the young loading officer admitted that he had trouble focusing "on a process which the atomic bomb...had rendered humdrum and obsolete."

Troubled or not, the bomb-loaders went on with the job. A few hours later, 131 of the long silver planes with even longer wings set out for Toyokawa; 37 others went to mine the Shimonoseki Straits. ("I have listened to intelligence officers briefing pilots on how to approach Japanese cities whose names they could scarcely pronounce," Murphy mused. "In the morning those cities were gone.") On Wednesday, August 8, 412 Superforts voyaged to Yawata, Fukuyama, and Tokyo. On Thursday, 95 bombed an oil refinery at Amagasaki, and *Bock's Car* dropped a plutonium bomb on Nagasaki.

By now, the morale problem was nagging Carl Spaatz,

U.S. forces dropped leaflets on Japan like the one pictured at right, which read: "Tomorrow the 14th day we will bomb Osaka. This bombing will be the last bombing of 1945."

明日十四日
大阪を くうしゅうします
このばくげきがさいごで
あります
一九四五年

U. S. A.

TSUCHIZAKIMINATO

NANAO

ISESAKI
KUMAGAYA
TOKYO

MIYAZU

HAMADA

OSAKA

HIROSHIMA
IWAKUNI
HIKARI
SHIMONOSEKI STRAITS

NAGASAKI

newly arrived in the Marianas to command the U.S. Army Strategic Air Forces. (USASTAF itself was new, created that August as an umbrella for the 20th Air Force in the Marianas, the Seventh Fighter Command on Iwo Jima, and the Eighth Air Force just establishing itself on Okinawa.) The newfangled bombs, Spaatz radioed, disturbed the men who had to fly "the prosaic type of operation." Would Henry "Hap" Arnold, the air force chief, please reassure them that their work was still important to the war effort?

Guided by the ferocious genius of Curtis LeMay, the Marianas-based B-29s had "scorched and boiled and baked to death" more than 200,000 Japanese, left millions homeless, and turned their cities into ash heaps. (The words are the general's, used in *Mission with LeMay: My Story* to describe the first and most terrible of the firebombing raids he launched against the Empire.) Aerially laid mines and submarine-launched torpedoes had starved them of raw materials. By August 1945, the Japanese army had a grand total of 13 million gallons of aviation gasoline on the home islands, and most of that was reserved for Ketsu-go, the operation intended to fling 10,000 suicide aircraft at the expected U.S. invasion fleet. Trainers and transports were modified to run on alcohol and pine-root oil. To conserve fuel, combat pilots were ordered to ignore enemy fighters and small formations of bombers—a policy that enabled the *Enola Gay* and *Bock's Car* to come and go without challenge. USASTAF, by contrast, had 15 million gallons of aviation gasoline on Tinian alone, an island smaller than Manhattan.

The two enemies had one quality in common though. They were both war machines, tightly wound and immensely difficult to stop. The Japanese soldier believed in fighting to the death, and even if it had been otherwise, the communications systems necessary for a quick surrender had been severely damaged. As late as Thursday evening, August 9, the government ministers in Tokyo, unable to communicate with Hiroshima by telephone or radio, were not entirely convinced that the United States had developed an atomic bomb. Such a bomb was certainly possible, and Hiroshima was certainly in ruins. But the "new type" weapon had exploded at 8:15 a.m.; perhaps it had caused breakfast cooking fires to ignite thousands of homes, causing a holocaust like the one that destroyed Tokyo after the 1923 earthquake. As for Nagasaki, they only knew that it had suffered a "severe attack of Hiroshima type," according to a bulletin handed to them that afternoon.

The ministers argued until midnight, then took the unprecedented step of asking the emperor, who was considered to be a god, for guidance. In a bomb shelter 100 feet below the Imperial Palace, they bowed their heads and listened to "the Voice of the Crane," whose family had ruled Japan for 124 generations. In his oblique fashion, Hirohito urged them to "bear the unbearable." The ministers dutifully ratified that advice, and at 7 a.m. on Friday, August 10, sent an equally oblique message to the neutral capitals of Stockholm and Bern: "The Japanese Government is ready to accept the terms enumerated in the joint declaration" of the Allied leaders at Potsdam, but no change could be permitted in "the prerogatives of His Majesty as a sovereign ruler."

On Guam, the largest of the Marianas islands and the first to be bulldozed into an airfield, Spaatz heard the news in the Quonset hut that served as his war room. Since B-29s were already loading for another voyage to the Empire, he hastily teletyped Henry Arnold's deputy, Brigadier General Lauris Norstad, who told him "to carry on with scheduled mission tonight."

The two enemies had one quality in common. They were both war machines, tightly wound and immensely difficult to stop.

Instead, Spaatz canceled the raid. Though citing unfavorable weather, Spaatz, an intelligent man, probably didn't want to risk sending bombers he might have to recall or, worse, be unable to recall in the face of a presidential order.

The *New York Times* featured the stand-down on its front page: "JAPAN OFFERS TO SURRENDER; B-29's, NAVY HALT ATTACKS." This posed a dilemma: If Spaatz resumed the bombing, the headline writers would conclude that negotiations had collapsed. The stand-down was therefore formalized. "All strategic air operations of USASTAF will cease at once," radioed a somewhat annoyed Arnold, "and any missions which may now be in the air en route to targets will be recalled."

As for the diplomatic response, it was delayed by hardliners in the United States, Australia, and especially the Soviet Union; the latter had just declared war on Japan and was sending armored divisions racing through Manchuria and Korea at the rate of 100 miles a day. When the telegram did go out, it conceded nothing: "the Emperor [will] be subject to the Supreme Commander of the Allied Powers." Worse, the telegram seemed to imply that the god would have to stand for election, a notion even more astonishing than expecting him to take orders from a foreign general.

The ministers spent Sunday, August 12, agonizing over this latest humiliation. Meanwhile, other Japanese exacted a blood price for the raids that had destroyed their cities. In Fukuoka, a truck drove up to Army headquarters, collected B-29 crewmen who had been shot down over Japan, and drove them to a lonely field, where, one by one, a lieutenant chopped off their heads with his sword.

They were not the first to die in this manner. The Japanese had beheaded dozens of airmen and used others for bayonet and archery practice. They'd locked them in animal cages and tied them to posts for passersby to torment. They'd burned them alive, buried them alive, dissected them alive, and cooked and eaten their body parts. Such atrocities were not confined to the war's end, nor even to military prisoners. From the very first day of its 14-year war, wherever it went on the continent of Asia or in the Pacific, Imperial Japan had

worked and starved and tortured its captives to death.

"We discussed it a lot," recalled Warren Morris, then a B-29 pilot in the 313th Wing on Tinian. "We wondered whether to bail out or not, because the word we had was that they were executing our fliers.... Oh, we talked about that. We knew that they were killing prisoners." Morris was 21 years old, just off the farm in Eldorado, Kansas.

President Truman spent that Sunday in his office, waiting for word from Tokyo, while crowds danced in Times Square, Piccadilly Circus, and along the Champs-Elysées. A more solemn crowd gathered outside the White House in Lafayette Park, mostly enlisted men and women in summer uniforms.

At the War Department, victory seemed so near that the generals became concerned about who would get the credit. There was the usual rivalry between Army and Navy, but in addition, Arnold wanted to justify the creation of an independent air force, answerable only to him and the president, and Lauris Norstad was particularly keen on getting that message through. "The surrender of Japan comes after the severest and most concentrated bombing campaign in history," he lectured Spaatz, who was drafting a press release. "It would be inconsistent with AAF dignity and restraint to make these statements boldly and brazenly." Still, the facts could be "woven into the piece so that no reader can fail to draw the...inference that air power was the outstanding factor in our victory."

Though an Allied victory had come to appear increasingly inevitable, Spaatz' cable book for August suggests otherwise. It is chockablock with plans to rush 720 B-29s to Okinawa, along with British and Canadian Lancasters; to put wing racks on the Superfort so it could carry 22,000-pound "Tall Boy" bombs; to improve its performance and step up its production; and to bring in new air crews on a schedule extending to March 1946. These messages are mixed with pleas for transport aircraft to fly a U.S. occupation army to Japan. And all the while, the generals argued over which city to destroy with the next atomic bomb. Spaatz nominated Tokyo for the "psychological effect on the government officials," while the War Department favored Sapporo.

This was not the White Queen, believing six impossible things before breakfast; it was just the bureaucratic looking-glass, reflecting all possible outcomes. Indeed, Carl Spaatz had been installed over Curtis LeMay largely because of his administrative talents, more useful now than combat genius.

The USASTAF B-29 stand-down lasted through Monday, August 13. But even before it had ended, Navy aircraft and

Army tactical bombers were on the prowl. And in Spaatz' war room on Guam, planners were at work in rumpled khakis, studying a wall-size map of the Empire and laying out what would be the last strategic air raid of World War II. When no word came from Japan agreeing to the Allies' demands, the raid was set in motion.

This was to be a "maximum effort" that would deploy every airworthy B-29 in the Marianas, and such a large mission raised a long list of concerns. The planners pondered the weather forecast and the lack of targets still intact enough to bomb. They worried about timing the launch of so many aircraft, about providing them with reliable radar images, about avoiding collisions over the target, and about bringing them home after 15 hours in the air. Out and back, each crew would be traveling a distance equal to that between New York and London.

In the end, the planners chose eight primary and secondary targets, along with some last-resort targets to give every formation at least one objective it could find by radar alone. Then they went to work with their slide rules. Depending on the likely anti-aircraft fire, a formation might be told to bomb as low as 10,000 feet or as high as 20,000 feet. Depending on whether its task was to burn a city or demolish a factory, it might carry incendiaries or explosives—and if the latter, the bombs could be anywhere from 100 to 2,000 pounds. The fuse might be the kind that produces an instantaneous explosion, so as to riddle pipes and storage tanks at an oil refinery, or a delayed explosion so the bomb would go off in the second story of a three-story building.

Lastly, each B-29 was given a fuel ration depending on its bomb load, distance to target, and place in the formation—anywhere from 6,300 to 7,000 gallons of gasoline. (Not every pilot agreed with these calculations, of course. "To hell with that!" George Bertagnoli, 26, of the 313th would tell his engineer. "Give me as much gasoline as you can. I don't want to come back here in the soup and have to circle and run out of gas.")

When historians mention the last raid of World War II, they treat it as an abomination, like the beheadings in the field outside Fukuoka. The Japanese murdered prisoners; the Americans destroyed cities. In *War Without Mercy* John Dower argues that Arnold "was desperately attempting to arrange 'as big a finale as possible' to end the war."

Arnold wanted to put 1,000 strategic bombers over Japan, as he had often done over Germany. He even authorized Spaatz to hurry the Eighth Air Force into combat, adding perhaps 200 Okinawa-based B-29s to the 800 available in the Marianas. ("Thank God," Spaatz replied.) Nevertheless, the image I get from the cable books, diaries, and mission reports is not one of bloodlust but of a machine gearing up for one final revolution, as it had revolved so often since the Marianas-based B-29s first bombed Tokyo in November 1944. In the bland language of the Tactical Mission Report: "At the time these missions were planned, peace negotiations were under way with Japan. The Commanding General gave orders for all Wings to be prepared to dispatch maximum effort forces on minimum time notice. Because it appeared that negotiations were being delayed by the enemy, these missions were ordered for 14-15 August."

In Tokyo, the government ministers had wasted Sunday, August 12, in argument; now Monday was following it. The civilians were ready to quit on any terms, but three military men—General Korechika Anami, General Yoshijiro Umezu, and Admiral Soemu Toyoda—wanted to fight on, believing they could make a U.S. invasion of Japan so bloody that the Americans would have to soften their terms. As Monday night wore on, Anami even considered joining a plot to seize

the Imperial Palace, to save the emperor from himself.

At 4 a.m. on Tuesday, August 14, the first airplane of the 313th Wing taxied onto Tinian's North Field. (I use Tokyo time throughout. It was 5 a.m. in the Marianas; in Washington, the staff officers were still sweltering through the previous afternoon.) The pilot ran his four 2,200-horsepower Wright engines to the red line, then released the brakes. The Superfort rolled along the asphalt for a mile and a half—picking up speed, lifting off, and settling down several times—before finally struggling into the air.

Empty, the Superfort weighed 37 tons, to which had been added 20 tons of gasoline, seven tons of bombs, and three tons of "miscellaneous weight," which included 11 young Americans with flak vests and steel helmets. The B-29 was desperately underpowered for its burden, and the pilot let it skim the blue-black Pacific while the engineer attempted to lessen drag by closing the cowl flaps with a haste never imagined by the designers at Wright, a move that carried the risk of overheating the engine. ("Let the son of a bitch burn!" George Bertagnoli once yelled when an engine burst into flame. *Sweet Sue* couldn't climb or return on three engines, but if the crew kept the flaming engine at full power, the fire might blow out. It did, and they flew the mission.)

Other airplanes followed at 40-second intervals for more than an hour, using the two runways alternately while a molten orange sun rose over the Pacific. "As one would leave, engines groaning under the heavy load, a tornado of coral dust whirled wildly over the runway," Charlie Murphy wrote in *Fortune* after the war. "Then as the commotion subsided, the tall stately tail of another B-29 would come gliding through the gray obscurity, like the dorsal fin of a huge fish, while on the far side of the field, on the taxiway leading to the head of the runway, other tails moved into position."

The formation was a long, loose line, with the bombers in front flying slower than those in the rear, allowing the stragglers to catch up and "thicken the stream" as they moved north. In most cockpits, the commander turned on the autopilot and the crew settled back to talk, eat, read, or write letters. "That was a millionaire's airplane," Bertagnoli said of *Sweet Sue*, bound for Iwakuni in western Honshu. "It was quiet, and you sat in a big chair, and it was totally comfortable."

So ordinary had these missions become that the press release had already left the mimeograph machine. At 7 a.m., Spaatz telephoned Norstad in Washington and read from communiqué number 11: "More than 800 Marianas-based B-29 Superfortresses dropped 5,900 tons of demolition and incendiary bombs on Japan on 14 August and in the early hours of 15 August." He named the primary targets, adding that "173 fighter airplanes [7th Fighter Command] from Iwo Jima escorted the bombers over Osaka, and struck airfields in the Nagoya area."

Norstad saw a way to improve the language. It was true that Arnold hadn't succeeded in mounting a 1,000-bomber raid (the 200 Okinawa-based B-29s didn't participate), but he had succeeded in launching more than 1,000 aircraft. So Norstad suggested that Spaatz start the communiqué to the effect that "more than 1,000 aircraft of the U.S. Army Strategic Air Forces operated against Japan in the last 24 hours."

"Good idea and will change," Spaatz replied.

At mid-morning, the first B-29 passed Iwo Jima. The low hump of Mt. Suribachi was a welcome beacon to the crew: outbound, their last sight of friendly territory; returning, their first chance to make an emergency landing. In Tokyo, the government ministers were again appealing to the emperor in what would be the first full-blown Imperial conference since the one that in September 1941 had authorized attacks on Hawaii, the Philippines, Malaya, Java, and Borneo. Without time to change to formal dress, some borrowed neckties for the event, and others had to attend in the high-necked *kokuminfuki* fatigues worn by civilians during the war. Perhaps to spare them embarrassment, Hirohito himself wore an army uniform. Following custom, the arguments on both sides were carefully laid out, with the diehards pleading for a chance to fight on.

Five hundred miles to the west, the 313th Wing made landfall at 11:31 a.m. Twenty minutes later, through gaps in the cumulus clouds, the crews were rewarded with a perfect view of the railroad yards at Iwakuni. "It was kind of a minor target," recalled pilot Warren Morris, then 21 and on his 34th voyage to the Empire. "We usually had bigger targets than that."

The wind was a scant 16 knots, and the only flak "two inaccurate, heavy bursts over the target." Of 115 Superforts setting out from Tinian, 108 actually released their bombs over Iwakuni, in clusters looking rather like confetti but weighing 776 tons.

In the Imperial bomb shelter, the ministers groaned and wept as the Emperor again told them to "bear the unbearable."

In the Imperial bomb shelter, the ministers groaned and wept as the emperor again told them to "bear the unbearable." Himself sobbing, Hirohito volunteered to do what had never been done before: He would go on the radio to announce the surrender in his own voice, which no one outside the court and government had ever heard. When the emperor left the hot, mosquito-ridden shelter, some ministers were so stricken that they dropped to their knees.

After making his breakaway turn from Iwakuni, Morris told his navigator to plot the heading for Hiroshima, 25 miles northeast. The young pilot wanted to see the desolation for himself. "So he did," Morris said, "and we dropped down to about 3,000 feet and flew all around Hiroshima and [that part of] Japan. I didn't think I'd ever be back, and I never have." (Of all the pilots I talked to, Morris was the only one who actually remembered the August 14 mission. It was that routine, and it fell among some of the most momentous events of the war.)

Meanwhile, mine-layers from the 313th splashed their silent cargo into the Shimonoseki Straits and other watery

chokepoints. The 58th Wing rained 982 tons of explosives on Hikari Naval Arsenal in western Honshu, and the 73rd Wing—escorted by fighters from Iwo Jima and flying high to avoid flak—salvoed one-ton bombs onto Osaka Army Arsenal. "Almost all the small machine shops and laboratories in central sections of arsenal were destroyed," concluded the Osaka mission report. "The large assembly type buildings and storage buildings in central and southern sections of plant were severely damaged or destroyed. Many direct hits visible on heavy machine shops at northern edge of arsenal." Nearly 95 percent of the bombs burst within 3,000 feet of the aiming point—something less than pinpoint accuracy—in Japan's second-largest city.

In its heyday, Osaka Army Arsenal had employed 60,000 workers, but with factory relocations, military conscription, and a false alarm that had delayed the commuter trains, only about 5,000 were on the job that noon, assembling cannon, antiaircraft guns, shells, and suicide submarines for the navy. (The workers included schoolchildren and Korean conscripts, recalled Ishimura Torataro, a welder. Unskilled and using old machinery, they produced generally shoddy materiel.) The Superforts demolished the arsenal and killed about 1,000 people within and without its high circular walls.

As expected, the flak was heavy, damaging 28 Superforts over Osaka. ("The Japanese Army made a brilliant success in hitting these planes," boasted a Japanese war communiqué, while admitting that the bombers had done great damage to the arsenal "and civilian residences.") At 2:30 p.m., the last B-29 closed its yawning bomb bay doors, made a right turn, and took up its course for Iwo Jima.

The world, at this moment, was again swept by a rumor of peace. At 2:49 p.m. a radio operator on Okinawa logged an English-language news flash from the Domei news agency: "An Imperial message accepting the Potsdam proclamation is forthcoming soon." Though under military control like all institutions in Imperial Japan, the news agency had been a generally trustworthy source throughout the war. On Guam, the armed forces radio broadcast the report at 3 p.m., setting off riotous parties among the service personnel not otherwise occupied.

They did not include the B-29 crews that would be flying the three night missions. The first Superfort of the 315th Wing took off at 3:42 p.m., bound for Tsuchizakiminato in northern Honshu. Since they would be bombing individually, they set out in leisurely fashion over the course of four hours. (For a while, the 313th Wing on Tinian had bombers both coming and going. The first B-29 returning from Iwakuni touched down at 6:04 p.m., the crew stubbled, stinking, and weary from 15 hours in the air; 12 minutes later, the first of the night raiders took off.)

In Tokyo, the government ministers labored over the words that would end not just the war but the history of Japan as they knew it. General Anami choked on one phrase: "the war situation grows more unfavorable to us every day." If that were true, he cried, the army communiqués had all been lies, and how could the emperor say such a thing? The words were changed to "the war situation has developed not necessarily to Japan's advantage," perhaps the most forlorn understatement of the war.

Scribes then translated the document into the language and script used at court, so arcane that two hours were needed to brush the characters onto parchment. Not until 10 p.m. did it reach the emperor, who signed it, affixed his seal, and returned it to his ministers to be ratified.

As they understood the matter, the surrender went into effect at 11 p.m., when the last of them—the transportation minister, as it happened—brushed his signature onto the document. They dispatched coded telegrams to Bern and Stockholm but otherwise told no one. (The leak to Domei had been unofficial, by a lower-ranking official afraid that the next atomic bomb would destroy Tokyo and therefore the country's ability to surrender.) More than

the bomb, the ministers feared revolt by their own army and navy. Thus it was in the utmost secrecy that the emperor sat down to record his decision for broadcast the next day.

At that moment the night raiders flew past Tokyo: the 73rd Wing bound for Isesaki, the 314th Wing bound for Kumagaya, along with some B-29s from the busy 313th. They carried white-phosphorus bombs and incendiary clusters—bomblets filled with magnesium and jellied gasoline. These were to be seeded at the rate of 225 tons to the square mile, the density that Curtis LeMay had found to yield the most destructive fires for the least expenditure. (In this respect, Japan, whose buildings were mostly made of wood, was much less costly than the sturdily built cities of Germany.)

The bombers passed close enough to set off air raid sirens in Tokyo, causing the electric supply to be shut off. The emperor's recording session was put off until midnight. It was still Tuesday morning, August 14, in the United States, and commuters were reading this headline in the New York Times, which was based on the Domei flash: "JAPAN DECIDES TO SURRENDER."

According to the men who wrote the history of the Army Air Forces in World War II, the night raiders reduced 45 percent of Kumagaya to ashes, and 17 percent of Isesaki. The job took a bit more than an hour, with the lead bombardiers using the radar return from the Tonegawa River to locate the cities—towns, really, each with fewer than 50,000 residents—while latecomers simply navigated by the flames.

Japanese accounts say that in Kumagaya 3,600 houses were burned, 234 people were killed, 3,000 injured, and 15,000 left homeless or otherwise bereft. The latter included Ozaki Kei, who to escape the heat jumped into the Tonegawa with her three-year-old daughter strapped to her back. So many burning houses fell into the river, she recalled, that even the water was hot.

The eighth "primary" was the Nippon Oil refinery at Tsuchizakiminato, and the last B-29 did not turn away from this area until 2:21 a.m. Wednesday morning. Its crew brought to 10,000 the number of USASTAF airmen who had flown to the Empire in the last 15 hours. Of those, only one failed to return: a fighter pilot shot down by flak. And the last B-29's bombs brought to 6,000 tons the weight of the explosives dropped in the last raid of World War II—a stupendous total, even by the standards of the war in Europe. Still, their destructive power equalled only half that of the bomb that vaporized Hiroshima.

In Tokyo, rebel officers murdered the commander of the Imperial Guards Division, surrounded the palace, disarmed its police, and seized technicians from the Nippon Broadcasting Company—but not the precious recordings, which were concealed in an office used by a lady-in-waiting to the empress.

In Switzerland, the Japanese envoy delivered the surrender message at 4:10 a.m. Tokyo time. Three hours passed before the Swiss got word to Washington: among other delays, their messenger was stopped by D.C. police for making a U-turn on Connecticut Avenue. In Tokyo, the sun was now rising on Wednesday, August 15, and the radio began periodic announcements that all listeners must stand by for a historic broadcast at noon, when they would hear their emperor's voice for the first time. "This is a most gracious act," the announcer reminded them.

On Guam, the news was logged at 8 a.m.: "You are hereby officially notified of Japanese capitulation." Half of Spaatz' night raiders were still in the air, strung out for 750 miles from Iwo Jima to the Marianas.

At noon, virtually every Japanese on the home islands listened to the emperor's high, metallic voice, broadcast from radios and public address systems. Some reacted violently: Military policeman chopped off the heads of American prisoners in Osaka and Fukuoka, an admiral led 11 navy aircraft in a suicide flight to Okinawa, soldiers tried to kill the prime minister, and perhaps 1,000 officers, including General Anami, cut open their bellies in the ritual of *seppuku*. But the vast majority only knelt and wept. The war was over, not quite four years after Japan had struck Pearl Harbor, eight years after invading South China, and 14 years after occupying Manchuria—steps on a journey that brought the Empire to such ruin as no other nation has ever suffered.

>SIGHTINGS<

In the Nama language from which it gets its name, the Namib desert means "an area where there is nothing." Yet even the most barren desert contains something—in this case the only hot-air balloon in the African country of Namibia. Owned and operated by Eric and Nancy Heseman, Namib Balloon Sky Adventures takes visitors aloft to provide a dramatic perspective of the Namib at dawn. At left, the company's balloon handlers, visible as blue dots, prepare to meet the balloon when it touches down. Once back to Earth, the balloon is quickly deflated (above) to prevent the winds from carrying it off again.

HAUNTED BY THE PAST

PHILIP MAKANNA

Philip Makanna's latest batch of Ghosts *includes this Grumman J2F-6 "Duck."*

Ghosts of the Skies: Aviation in the Second World War *by Philip Makanna. Chronicle Books, 1995. 160 pp., color and b&w photos, $40.00 (hardcover).*

To flying buffs, the title "Ghosts" evokes not playwright Henrik Ibsen but California photographer Philip Makanna. Both his previous books, beautiful photo albums of resurrected and restored classic warbirds, are "Ghosts" with different subtitles. And for 16 years his annual calendar—more than two feet long when opened, each month featuring aircraft of the 1930s or '40s in brilliant color—has been labeled "Ghosts."

But this Ghost book has a different and effective twist. Makanna has supplemented his great (and well-known) color photos with archival black-and-white photos of airplanes and people. You'll see, for example, a replica of a Stuka dive-bomber (as ugly as the Nazis themselves) counterbalanced by two wartime photos: a Stuka hauling out as it releases three bombs and a London fire storm that silhouettes a statue holding a cross on a roof above the burning cityscape.

Text for this spread comes from British Prime Minister Winston Churchill's "We shall never surrender" speech—a paragraph that raised the remaining hairs on my head and left me eager to climb into a cockpit.

Maybe the cockpit of a Royal Air Force Spitfire. A few pages on, one of those exquisite little airplanes bares its gray belly as it rolls inverted above the earth. It's aiming straight at Mussolini and Hitler, who appear on the facing page. Nice juxtaposition. There's another of an old Navy Wildcat, turning toward a green island as though it had just left the wartime carrier deck on the opposite page. Makanna dug up 38 of the 66 old photos at Britain's Imperial War Museum. Others came from Japan, the U.S. National Archives, and private sources.

Makanna takes his own pictures from a T-6 with the help of a few pilots who know what he wants and how to get it. "It sometimes takes several passes to find the right lighting and background and flight attitude, all at once," he says.

Here are the dazzling results of those missions—demanding, but not as rough as the real thing the old photos show. On one page, an RAF squadron commander, just landed, stares with ancient, haunted eyes. On another, a bombardier home from hell sits back against his airplane's landing gear, his eyes on nothing at all. You'll remember those two—and much more—from this splendid book.

—Edwards Park is a contributing editor to Air & Space/Smithsonian *and the author of* Nanette, *a memoir of the P-39 he flew during World War II (Smithsonian Institution Press, 1989).*

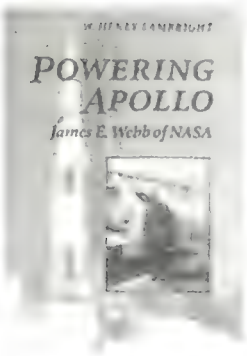
FOR THE KIDS

Airplanes: A Fold-Out Book. *Text by Nicholas Harris, illustrations by Martin Woodward. Rand McNally, 1995. 16 pp., color illustrations, $12.95 (hardcover).*

Never mind that it says "ages 7–12"—airplane lovers of all ages can appreciate this meticulously illustrated book, which folds out into a Boeing 747 cross-section more than five feet long, complete with sidebars and illustrations. The panel's other side, designed as a book, contains 37 illustrations, from a 1783 paper-lined linen balloon to the Wright brothers' 1903 *Flyer* to the not-yet-in-service Eurofighter 2000.

Powering Apollo: James E. Webb of NASA *by W. Henry Lambright. Johns Hopkins University Press, 1995. 271 pp., b&w photos, $35.95 (hardcover).*

Biographies of the leading figures of the National Aeronautics and Space Administration are practically non-existent. W. Henry Lambright, professor of political science and public



administration at Syracuse University, helps rectify the situation in a study of the career of James E. Webb, NASA's second administrator. Webb's tenure covered 1961 through 1968—the critical, formative time for NASA's signature achievement, the Apollo program.

As administrator, Webb embodied the grand themes of the 1960s: the appetite for progress and an activist government, and the belief that science and technology would provide social solutions, not create problems. For Lambright, Webb is a symbol of these grand themes, opening up questions on the exercise of political power through public bureaucracies.

How, Lambright asks, was NASA, a public bureaucracy with limited authority, able to pull off one of the greatest accomplishments of the 20th century? In particular, what role did Webb play? Webb did have the support of Presidents Kennedy and Johnson. But presidential commitment alone was not sufficient. Active leadership, marked by the strategic exercise of bureaucratic power, also was required. This is the sense in which Webb "powered" Apollo, Lambright writes, and the book's central task is to elaborate on this thesis.

Lambright carefully shows how Webb honed his political and administrative skills through his early career, then brought them to bear on the special problems of NASA during Apollo. Tours as a staffer in Congress, a well-connected lawyer-lobbyist, director of the Bureau of the Budget and undersecretary of state in the Truman administration, and corporate executive in the 1950s all served Webb at NASA. Equally important was his well-informed interest in the theory of public administration. As a Democrat steeped in New Deal perspectives, he believed that government should have an active role in improving the nation's economy. Even more, Webb believed that science and technology, appropriately directed, were the most effective instruments for accomplishing this improvement.

Webb used this mix of experience and belief at NASA. His administrative skill helped forge working relationships among the agency's independent field centers and the legions of industrial and university contractors. But Webb's sense of his job went well beyond this grand managerial accomplishment. He wanted NASA to be a model organization, doing the public's business in space but also leveraging its power and resources to enhance the commonweal. Webb's legacy here, as Lambright shows, is ambiguous, reflecting the traditional unease American

political culture has with the exercise of federal power, especially by unelected bureaucrats.

Lambright does not fully deliver on his objective of linking Webb's complex personality with the larger themes of science, technology, and political power in American life in the decades after World War II. Nonetheless, his study of James E. Webb stands as a singular contribution to our understanding of the most dominant figure of the Space Age.

—Martin Collins is a curator in the National Air and Space Museum's department of space history.

FYI

Air University Press produces books, monographs, and papers related to U.S. Air Force topics. To receive a copy of its reading guide, write to: Air University Press, 170 West Selfridge Street, Maxwell AFB, AL 36112-6610, or call (334) 953-2773.

Fighter Pilot's Heaven *by Donald S. Lopez (foreword by Frank Borman). Smithsonian Institution Press, 1995. 288 pp., b&w photos, $24.95 (hardcover).*

I have always wondered what they did and how they did it at Eglin Air Force Base. Now I know. *Fighter Pilot's Heaven* is the intriguing, detailed chronicle of Eglin's glory years, as told by Donald S. Lopez, a National Air and Space Museum historian who lived the history he recounts. The book is so full of anecdotes, technical data, dates, numbers, and locations that either his memory is remarkable or he is the only aviator to my knowledge who ever kept useful records.

Lopez did combat in the Asian theater of World War II and another lengthy tour of "combat" at Eglin Air Force Base in Florida, where the airplanes developed at Ohio's Wright Field and California's Edwards Air Force Base were put to the acid test of combat usefulness. He and his peers at Eglin became the legendary heroes of flight test lore and of the latter-day Air Force hierarchy.

Lopez was a key player in the explosion of aeronautical technology that followed World War II, and in his six years at Eglin he contributed to almost every development in the U.S. combat airplane inventory. He was there for the beginning of the cold war weaponry battle, which eventually led to the victory of *perestroika*.

With an understated style characteristic

of the author but uncharacteristic of most fighter and test pilots, "Lope" takes us through his experiences with the old airplanes that had won the war and the new jets that were to win the peace. He flew virtually all of the World War II combat airplanes in every known combat situation, within and beyond their envelopes. He was also among the few who flew our first jet, the P-59, a feeble beginning for the modern jet-dependent air force. Lopez writes about these experiences with readable authority.

The writer reveals previously unpublished idiosyncrasies of the airplanes and of the men who, every day, gambled against the odds with those idiosyncrasies. A complex, hazardous, and empirical technology becomes much more understandable as told by Lopez. No library of modern history would be complete without this account.

Fighter Pilot's Heaven is truly a story of a compelling way of life. Its primary premise is that risk is to be challenged. That is the core of the fighter pilot. That is the core of Don Lopez's story.

—A. Scott Crossfield is a former test pilot who flew the X-15, among other aircraft.

America's Pursuit of Precision Bombing, 1910–1945 *by Stephen L. McFarland (foreword by Richard P. Hallion). Smithsonian Institution Press, 1995. 368 pp., b&w photos, $29.95 (hardcover).*

The United States entered World War II believing its airmen could "drop a bomb into a pickle barrel from 18,000 feet," as a journalist boasted in 1939. Carl Norden would make it possible: Although the devices he designed did not, in fact, get bombs into pickle barrels, they nonetheless revolutionized the ability of bombers to strike closer to their targets. German by blood, Dutch by birth, and Swiss by education, Norden served the U.S. Navy, which broke the law and battled the U.S. Army to get exclusive rights to his genius. The result was the Norden bombsight, on which the nation spent almost as much as it did on developing atomic energy (see "The Secret Weapon," Feb./Mar. 1995).

Alas for precision! Over Germany, flak and fighters drove U.S. Army bombers to 25,000 feet—from that altitude they were lucky to hit a 500-acre factory, never mind a pickle barrel. "We had dropped 422 tons of bombs," a sarcastic airman said of one such mission, "and...333.4 tons had been wasted on homes, streets, public parks, zoos, department stores, and air-raid shelters." Nonetheless, the raid closed the I.G. Farben synthetic rubber plant for a month—a more humane result than the "city-busting" of the Royal Air Force.

Having hogged the early production of the Norden sight, the U.S. Navy abandoned it, depending instead on brave pilots who turned themselves and their Dauntless dive-bombers into primitive missile launchers.

Over Japan, precision lost all meaning. On August 6, 1945, Major Thomas Ferebee froze the Aioi Bridge in his Norden sight. With perfect visibility and no flak to trouble him, one of the Army's best bombardiers missed by 800 feet. Not that it mattered: His bomb destroyed the bridge, along with the rest of Hiroshima.

More recently, the United States set out on another attempt to deliver explosives exactly on target, sparing zoos and department stores. The result was the "smart bomb" of the Persian Gulf war, which I hope will soon receive the same intelligent scrutiny as Stephen McFarland has given to the pickle barrel era.

—Daniel Ford wrote "The Last Raid," which appears in this issue.

CALENDAR

July 28–August 14
Freedom Flight America. More than 300 World War II warbirds will make a coast-to-coast journey, kicking off with a fly-by of the *Queen Mary*, docked in Long Beach, California, and culminating with an "aerial parade" past the Statue of Liberty in New York. (312) 493-9500.

August 4–6
Magic of Alexandria Balloon Festival. Alexandria Field airport, Pittstown, NJ, (908) 735-0870.

August 5 & 6
Wings & Wheels: 25th Anniversary Crawford Meet. Cuyahoga County Airport, Richmond Heights, OH, (216) 721-5722.

August 10–13
Sentimental Journey Fly-In. William T. Piper Memorial Airport, Lock Haven, PA, (717) 893-4200.

August 12 & 13
Beaver County Airshow. Chippewa, PA, (412) 846-9922.

August 18–20
Roscoe Turner Hot Air Balloon Race & Golden Age Replica Fly-In. Roscoe Turner Airport, Corinth, MS, (601) 287-5269.

August 19
Air Show. Hill Air Force Base, UT, (801) 777-7469.

August 26 & 27
International Air Show. Shearwater, Nova Scotia, Canada, (905) 465-2725.

September 1–3
Hayward Air Fair '95. Hayward, CA, (510) 443-2399.

September 2–4
World War I Aerodrome Fly-In. Guntersville Airport, Guntersville, AL, (800) 526-6072.

September 8–10
Mid-Eastern EAA Fly-In. Municipal airport, Marion, OH, (513) 849-9455.

September 9 & 10
Fairchild Homecoming—The People and the Planes. Washington County Regional Airport, Hagerstown, MD, (301) 745-5708.

September 30–October 1
Trains, Planes, and Automobiles—A Transportation Show. Mid Atlantic Air Museum and Reading Regional Airport, Reading, PA, (610) 372-7333.

CREDITS

The Mars Paint-by-Number Set. Peter D. Zimmerman is a nuclear physicist and Washington, D.C.-based consultant in national security and arms control.

The Rockets' Red Glare. Kip Cassino, a Delaware-based writer and researcher, can still name most of the airplanes that flew over the air bases where his father was stationed while he was growing up.

Look! Up in the Sky! Tony Reichhardt is a frequent contributor to *Air & Space/Smithsonian*. His last feature was "The Cyberspace Program" (Oct./Nov. 1994).

Computer illustrator David Peters bends digital reality from a studio in Venice, California.

Munich Airport's Thirty Years' War. Lester A. Reingold, a freelance writer based near Washington, D.C., is a frequent contributor. He extends thanks to Wolfgang Sardison of the German publication *Süddeutsche Zeitung* for his help with this article.

The Mars Mission to Earth. Science writer Billy Goodman's last article for *Air & Space/Smithsonian* was "Practicing Safe Software" (Aug./Sept. 1994).

This Is Only a Test... Matthew Jaffe is a freelance writer living in Los Angeles.

Chad Slattery's photographs have been appearing in *Air & Space/Smithsonian* since the magazine's third issue.

Whole Lotta Jumpin' Goin' On. Frank Kuznik is a regular contributor to *Air & Space/Smithsonian*. His last feature was "To Make a Vacuum Cleaner" (June/July 1995).

When Erik Hildebrandt isn't shooting pictures, he's usually helping out at an airplane restoration shop near his Minneapolis home.

The Last Raid. Daniel Ford wrote *Flying Tigers: Claire Chennault and the American Volunteer Group*, recently released in paperback by Smithsonian Institution Press. For this article, Gohara Ryoichi helped with translations from Japanese.

Greg Harlin is a member of the illustration studio Wood Ronsaville Harlin, Inc., in Annapolis, Maryland. Although a seasoned airplane passenger, he refuses to test his wings until the wax hardens.

On the Edge. Lance Thompson is a freelance writer based in Sun Valley, California. His last story for *Air & Space/Smithsonian* was "The X-Hunters" (Feb./Mar. 1995).

"The Satellite Sky" Update/49

These regular updates to "The Satellite Sky" chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

New launches

90 to 300 MILES

- GFZ-1 4-19-95 MIR
- Spektr 5-20-95 TT
- Cosmos 2313 6-8-95 TT

300 to 630 MILES

- ERS-2 4-21-95 KOU

21,750 to 22,370 MILES

- GOES-9 5-23-95 CAC
- AMSC-1 4-7-95 CAC
- Intelsat 706 5-17-95 KOU
- UHF/FO-5 5-31-95 CAC

DATA: SAUNDERS KRAMER

Deletions

90 to 300 MILES

Cosmos 2244 down 3-18-95
Cosmos 2137 down 4-3-95
Cosmos 2290 down 4-4-95
Cosmos 2311 down 5-31-95
Progress M-27 down 5-23-95

Inoperative but still in orbit

90 to 300 MILES

Cosmos 2258
Cosmos 2264

300 to 630 MILES

IRS 1A
Cosmos 2184

21,750 to 22,370 MILES

RCA Satcom 7

FORECAST

In the Wings...

Return of the Koncordski. The Tu-144 was the Soviet Union's entry in the supersonic-transport sweepstakes three decades ago. Although the Soviet craft flew before the Concorde, it was soon outclassed by its Anglo-French rival and eventually taken out of service. Today a team headed by NASA's high-speed research program is bringing a Tu-144 out of mothballs and converting it into a flying laboratory to research the realities of high-speed commercial flight.

PLUS—Full-Color Poster: The SSTs. Noted illustrator John Batchelor (who did *Air & Space/Smithsonian*'s USS *Abraham Lincoln* poster) portrays the Concorde and the Tu-144 in another dazzling poster.

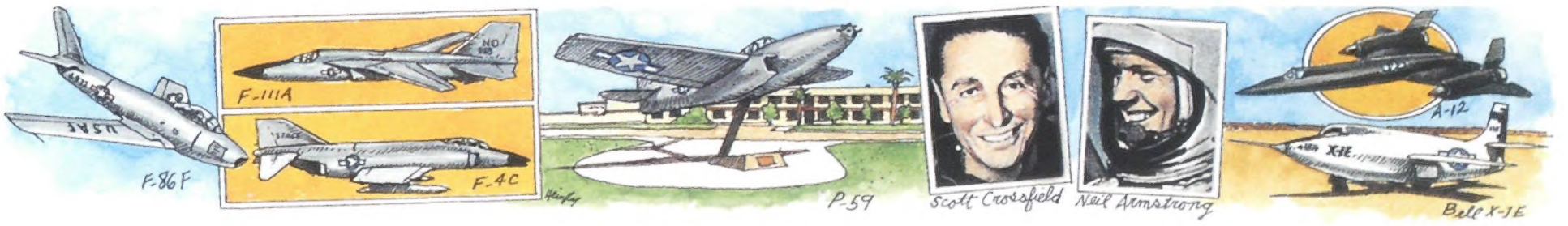
Mars Underground. Some NASA scientists continue to believe that life once existed on Mars because they have witnessed the tenacity of life in the most hostile environments on Earth. Exobiologists are now studying what may be evidence of microbes in New Mexico's vast Lechuguilla Cave.

Homecoming. Last August the remains of a fighter pilot were recovered by the U.S. Army for identification and burial. He had been flying a P-47 Thunderbolt in the Battle of the Bulge, and the crash site was discovered four months before the 50th anniversary of his death.

Pilots on a Mission. Mission Aviation Fellowship makes over 80,000 flights a year in some of the wildest territory in the world. And on every trip, each of the fellowship's 100 pilots flies by the Book.

Room with a View. The accommodations at the U.S. National Science Foundation's Antarctic observatory are spare, but polar aridity and a 9,300-foot elevation make it one of the best places on Earth for sightseeing in the infrared and sub-millimeter regions of the spectrum.

The Day I Flew on Lindbergh's Wing. Pilots stationed on the island of Biak were skeptical of the plan to extend the range of their P-38s to 1,000 miles until one of the great aviators of the age paid a visit to show them how it was done.



JOHN HEINLY

On the Edge

It's the place where America's first jet took to the skies, where Chuck Yeager broke the sound barrier, and where the first space shuttle returned to Earth. High above this Mojave Desert base, pilots like Scott Crossfield, Neil Armstrong, and Joe Walker coaxed state-of-the-art aircraft on to multi-Mach performances. "No other place has witnessed more aviation milestones in the last 50 years than Edwards Air Force Base," says Jim Young, chief historian of the Air Force Flight Test Center at Edwards.

But for years, the base had no museum to display the riches of its past. As Pete Knight, a former Edwards test pilot who once took an X-15 to an unprecedented Mach 6.7, recalls, "Every day we were seeing historic airplanes leaving Edwards and going to other museums." Federal law prohibits using taxpayer money for construction of an Air Force museum, so in 1983 a group of business people, aviation buffs, and test pilots got together and formed the Flight Test Historical Foundation to raise the necessary funds.

The responsibility for developing the facility went to Chief Master Sergeant Doug Nelson. Nearing the end of a 22-year Air Force career, Nelson had done volunteer work in various Air Force museums, earned a bachelor's degree in history through night courses, and taken charge of maintaining the few historic aircraft still at Edwards. In 1986 he retired from active duty to work full time on creating the museum.

Nelson went after one-of-a-kind aircraft, or the first of a breed. By working out a series of swaps with other collections, he got hold of the first General Dynamics F-111, a tactical fighter-bomber that pioneered variable-sweep wing design; the first Lockheed A-12, the forerunner of the SR-71 Blackbird reconnaissance craft; and the first production McDonnell Douglas F-4C Phantom II, an all-weather Vietnam-era fighter-bomber. That aircraft has particular significance for Nelson, who began his military career as an "egress technician," servicing ejection seats. "The F-4C was the first airplane I ever worked on, as a lowly one-striper, back in 1964," he says. Not just the same model—the very same airplane.

Getting a museum-size collection of artifacts together turned out to be a lot easier than getting a museum. Even though the money was being raised privately, the facility was to be operated by the Air Force, so the plans for it were vulnerable to shifts in military bureaucracy. Since the museum program began, the Air Force Flight Test Center has had five commanders, and each time the administration changed, so would the museum plans. Finally, when a dime store in a base shopping center became vacant in late 1990, Nelson got authorization to use it as an interim site.

Air Force Flight Test Center Museum, Edwards Air Force Base, CA 93524. Phone (805) 277-8050. Open Tues.–Sat., 10 a.m.–5 p.m; closed Federal holidays. Admission free. Call before visiting; entry to base is occasionally restricted.

Funding for the new facility was modest. Says Jim Young, "The end of the cold war was in sight, and there just wasn't as much money available from the large [aerospace] companies." To remodel the store, Nelson scrounged, scavenged, begged, and borrowed the materials he needed. He did most of the research and constructed the majority of the exhibits, even cutting the lettering out of sheet vinyl.

The museum finally opened last year, complete with a video theater, research library, and gift shop. The displays include such artifacts as an XLR-99 rocket engine, the type used on the X-15s; an escape capsule from the supersonic B-58 bomber; and an ejection seat from an F-105 fighter-bomber. Though the aircraft in the collection are too big to fit in the building, one entire wall is filled with scale models of those whose first flights ended at Edwards, from a version of America's first jet fighter, the P-59, to the Air Force's latest transport, the C-17. When Chuck Yeager paid a visit, he looked over the collection and repeated: "Flew that, flew that, flew that..."

The museum's aircraft are dispersed around the base; 16 are presently on display, including an F-86F Sabre, the Bell X-1E, and a T-33A Shooting Star. The foundation hopes to eventually fund construction of a permanent museum on a 335-acre lot, where most of the 65 or so craft in the collection can be shown. Among those already on the site are the F-111, a B-52, an F-104 that flew chase on the first SR-71 flight, and a Gloster Meteor, Britain's first jet fighter, which was evaluated at Edwards after World War II. Blackbird fans will find the A-12 displayed next to an SR-71 at the museum's Blackbird Airpark in neighboring Palmdale.

But the main attraction remains Edwards itself. This is the holy land of flight testing, where for half a century pilots and engineers have pushed back the boundaries of aeronautical possibility. "I'll tell you what it's all about," says Nelson; "to see the glint in a grandfather's eye when he brings his grandson here and points to one of the airplanes and says, 'I worked on that.' "

The Flight Test Museum gets about 1,000 visitors per month, an impressive average considering Nelson has no advertising budget and public affairs tours of the base don't even stop at the museum. The curator continues to look for better ways to tell the Edwards story. The next step will be an aircraft display in front of the present museum, including the first two-seat F-16, a World War II-era Beech C-45 light transport, and the F-4C that Nelson serviced when he began his Air Force career 30 years ago. "I want it right outside my office window," he says. That way, the man who put together the Air Force Flight Test Center Museum can lean back in his chair, look out his window, and say to himself: *I worked on that.*

—Lance Thompson

The average dream
This isn't your

Chances are it began before you even had a license. That deep-rooted yearning for one to call your own. And while most of your nocturnal fantasies have come and gone over the years, this one seems to reappear every time you turn out the bedroom light – with its door open and engine running. Well, you're not alone. Because for more than 40 years, people have been losing sleep over Corvettes. And the 1995 'Vette is no exception – with a 300-horsepower 5.7L LT1 engine, ASR

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